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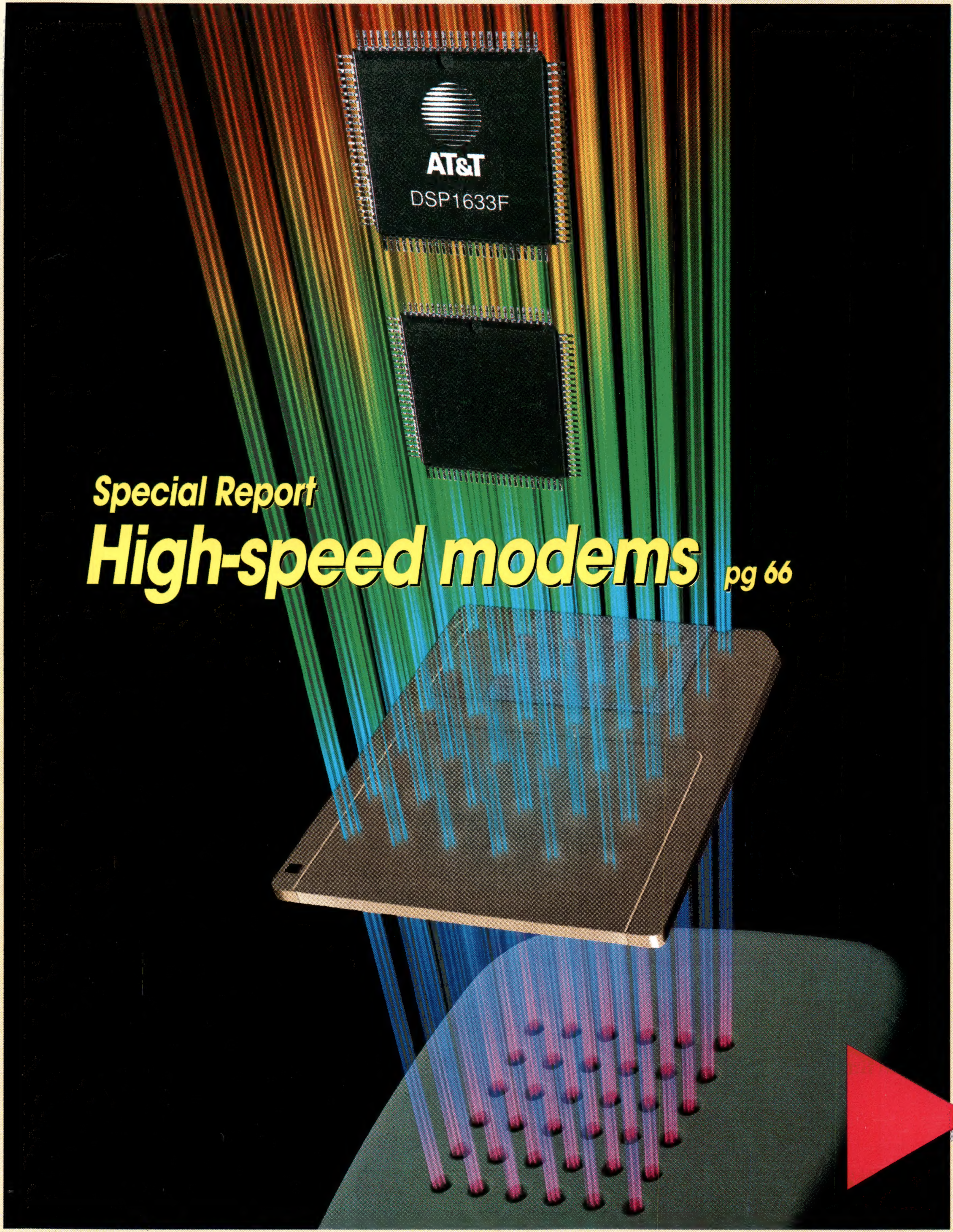

Special Report

High-speed modems *pg 66*

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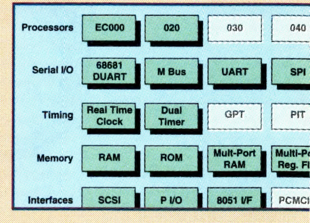
New Product Intros



Processors	EC000	020	030	040
Serial I/O	68681 DUART	M Bus	UART	SPI
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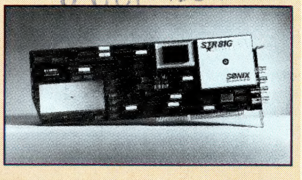
Memory	RAM	ROM	Mult-Port RAM	Multi-Po Reg. Fi
Interfaces	SCSI	P I/O	8051 I/F	PCMCI

68000 family becomes an ASIC core pg 15

8 JUL 1994



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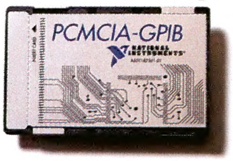

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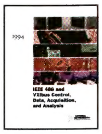

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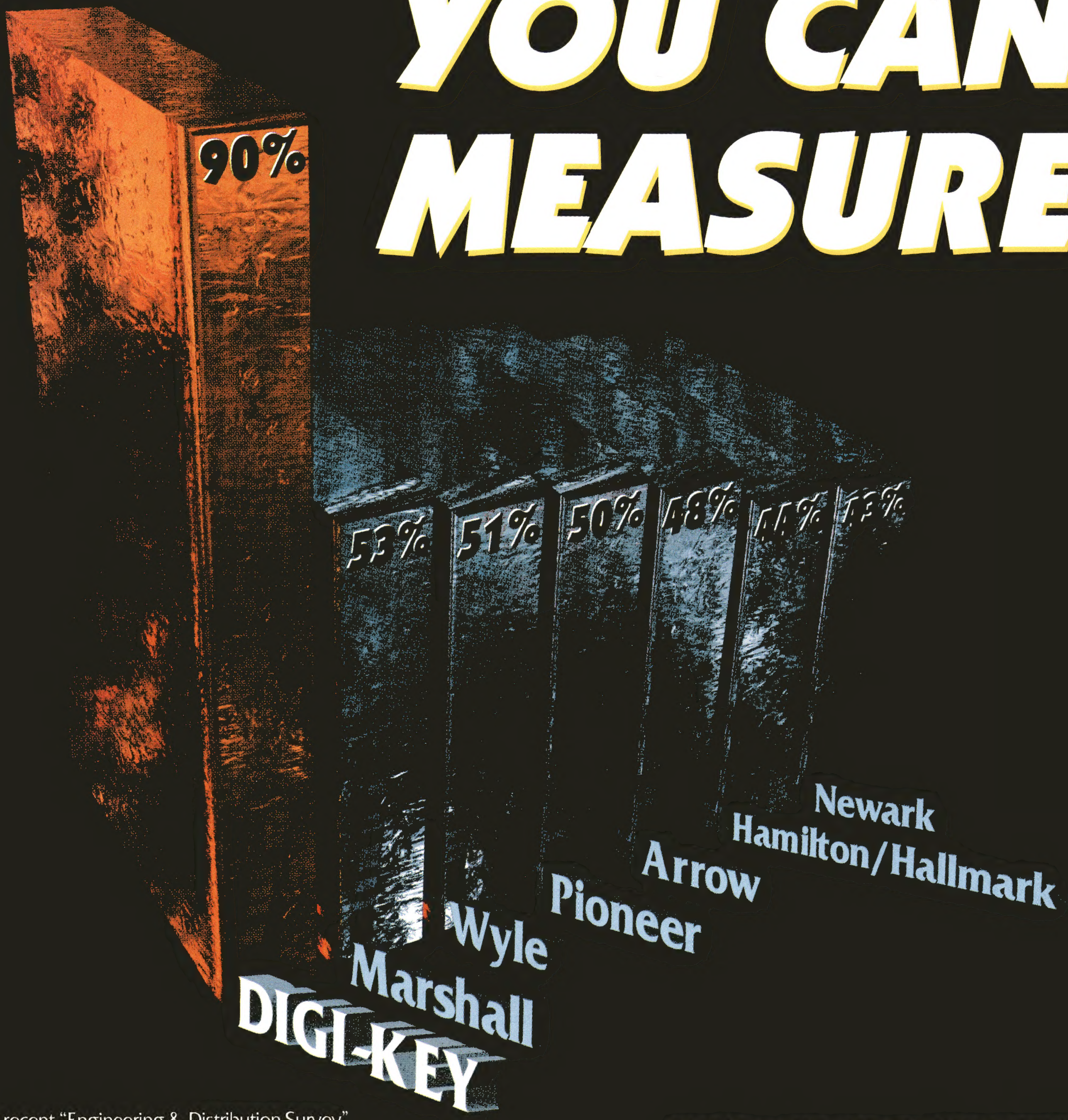

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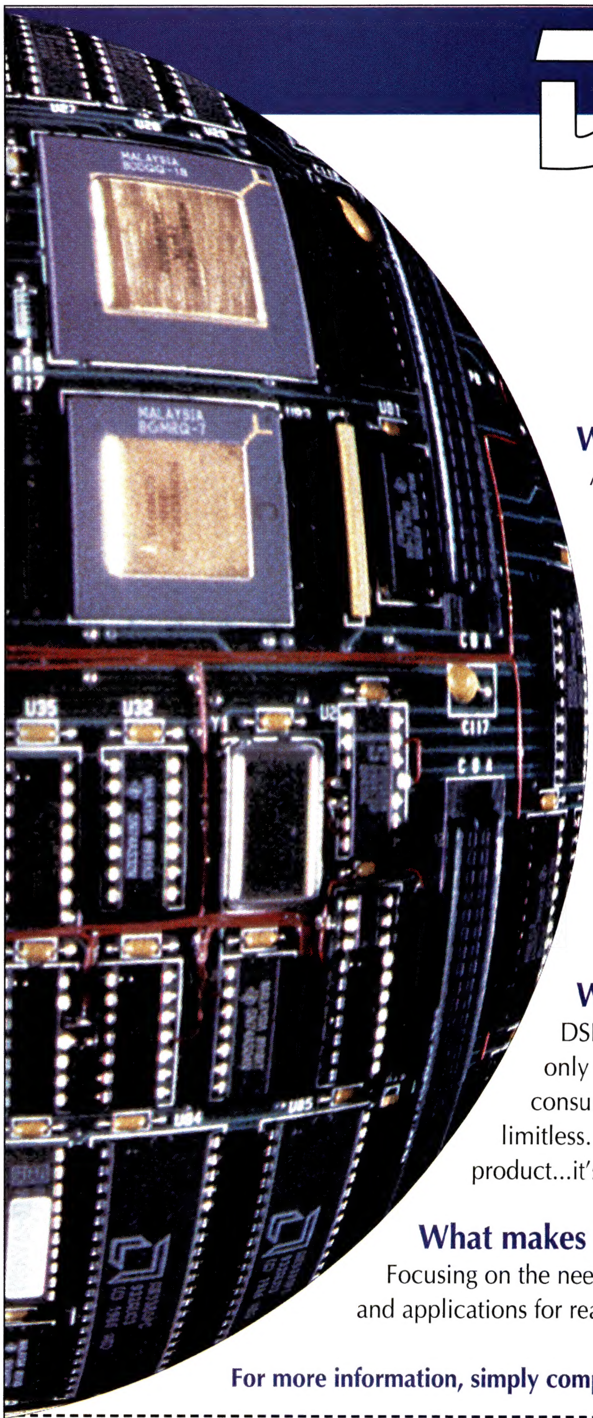

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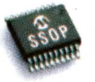

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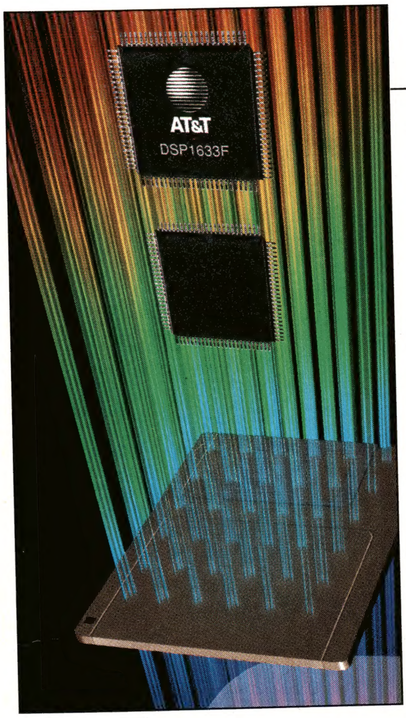

On the cover: Modems operating at 14.4 kbps are still standard workhorses for most applications. But power users will get a boost from a modem standard that doubles that rate. See our Special Report, which begins on **pg 66.** (Photo courtesy AT&T)

SPECIAL REPORT

High-speed modems 66

High-speed modems help reduce telephone bills and speed remote access to data. Currently, you can choose between two nonsanctioned standards to achieve data rates faster than V.32bis. But expect a UTI-T-sanctioned, 28.8-kbps standard—albeit untested—this year.—*John Gallant, Technical Editor*

DESIGN FEATURES

Internal debuggers simplify µP pc-board verification 103

When you must keep the cost of a design to a minimum, try using µPs having background-debug mode, which reduces parts count, lowers board cost, and improves reliability.—*Jim Hebert, Tektronix Inc*

Transition maps guide successful asynchronous state-machine design 111

To avoid the risks of asynchronous logic, designers too often sacrifice system performance by using synchronous designs. Transition maps, however, help designers avoid the risks in asynchronous logic—and recover lost performance.—*Ricardo O Rabinovich, Ascom Timeplex Inc*

Test high-speed drivers with bursts and pseudorandom bit patterns 133

Combine a high-performance, dual-channel pulse generator having burst and pseudorandom bit-stream capabilities with a high-bandwidth sampling oscilloscope for an effective and reliable way to characterize high-speed drivers.—*Andreas Pfaff, Hewlett-Packard GmbH*

DESIGN IDEAS

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Fast integer multipliers fit in FPGAs 80
Dual-polarity peak detector operates from single supply 82

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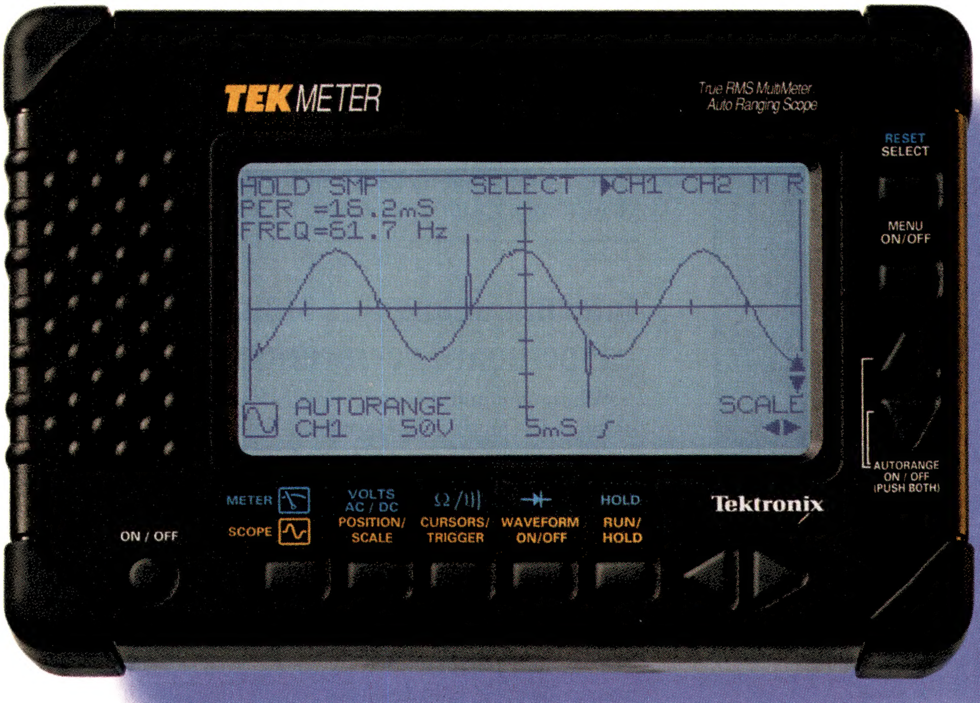

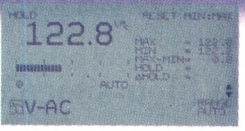

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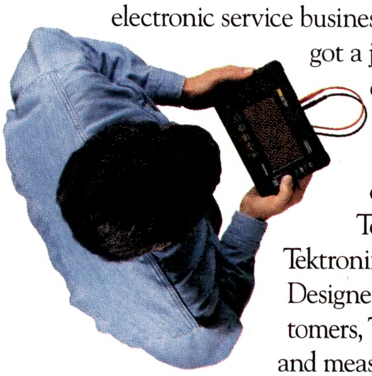

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Diverse PCMCIA add-ons present difficult choices 43

Abundant, inexpensive PCMCIA card drives make it easy to add credit-card-sized peripherals to desktop computers and embedded systems. But finding the right drive for your application isn't so easy.—*Gary Legg, Senior Technical Editor*

A surfeit of power-supply voltages plagues designs of compact products 55

With logic-supply voltages multiplying like rabbits, designers of small products face some tough architectural decisions. —*Dan Strassberg, Senior Technical Editor*

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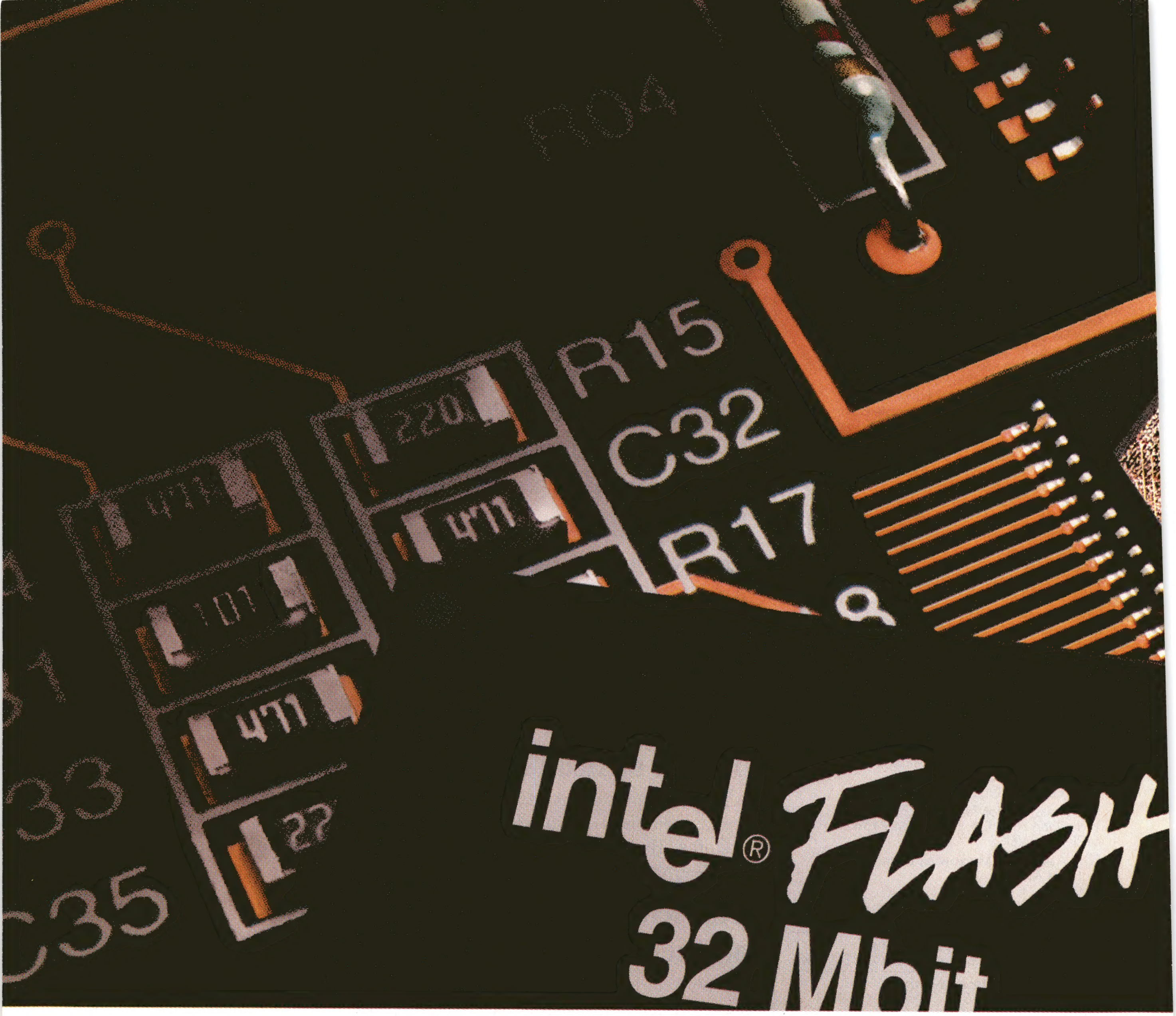

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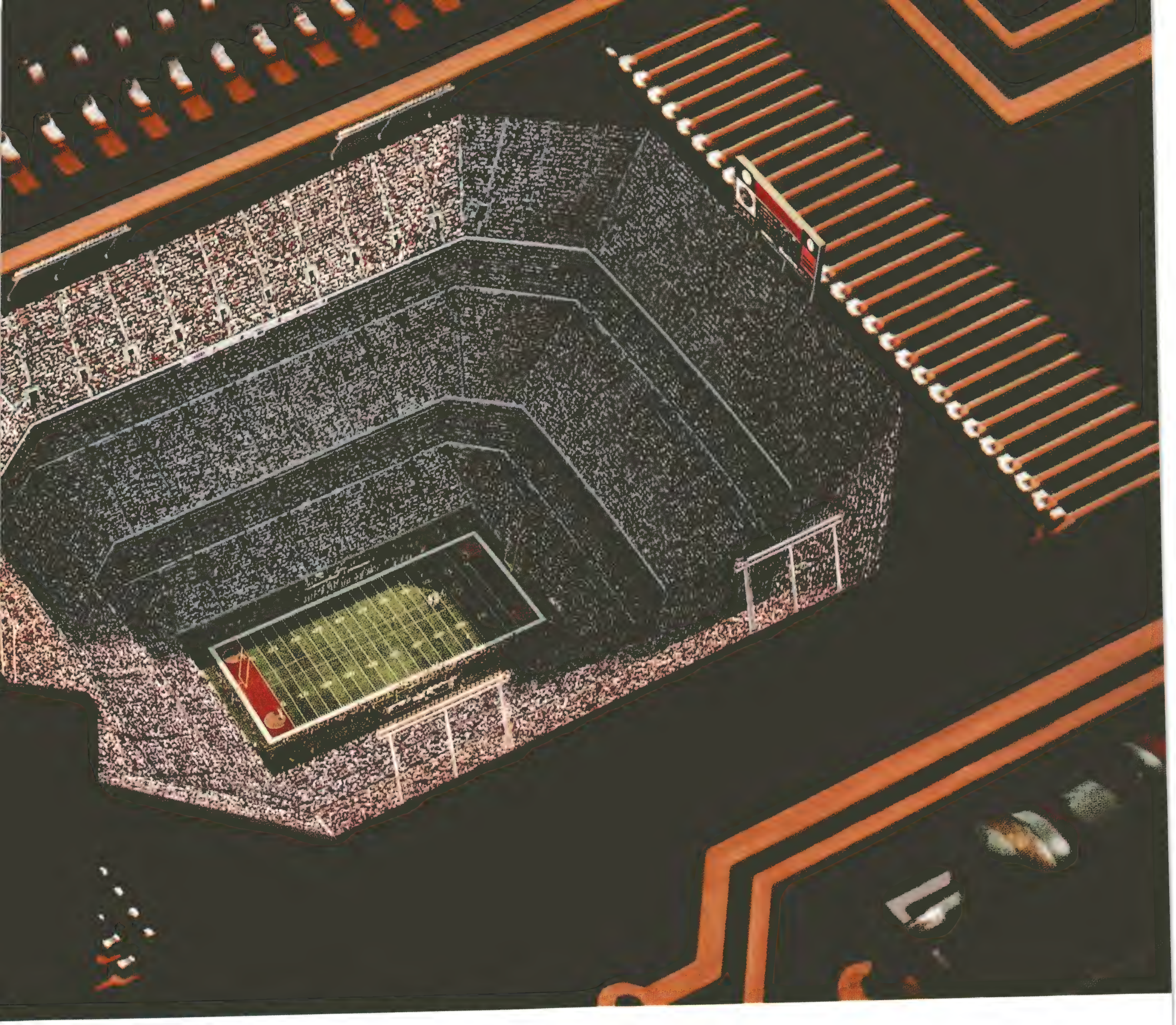

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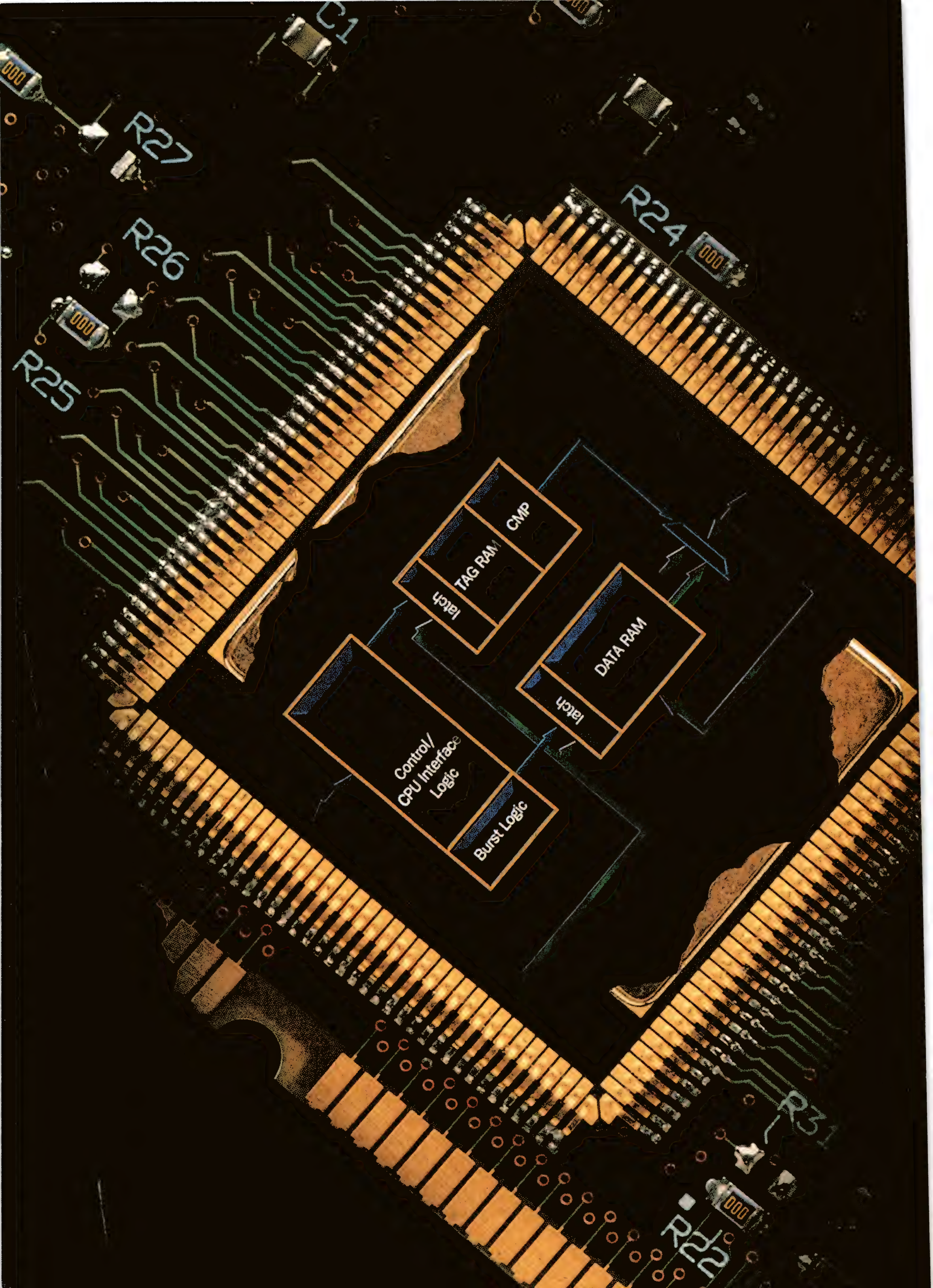
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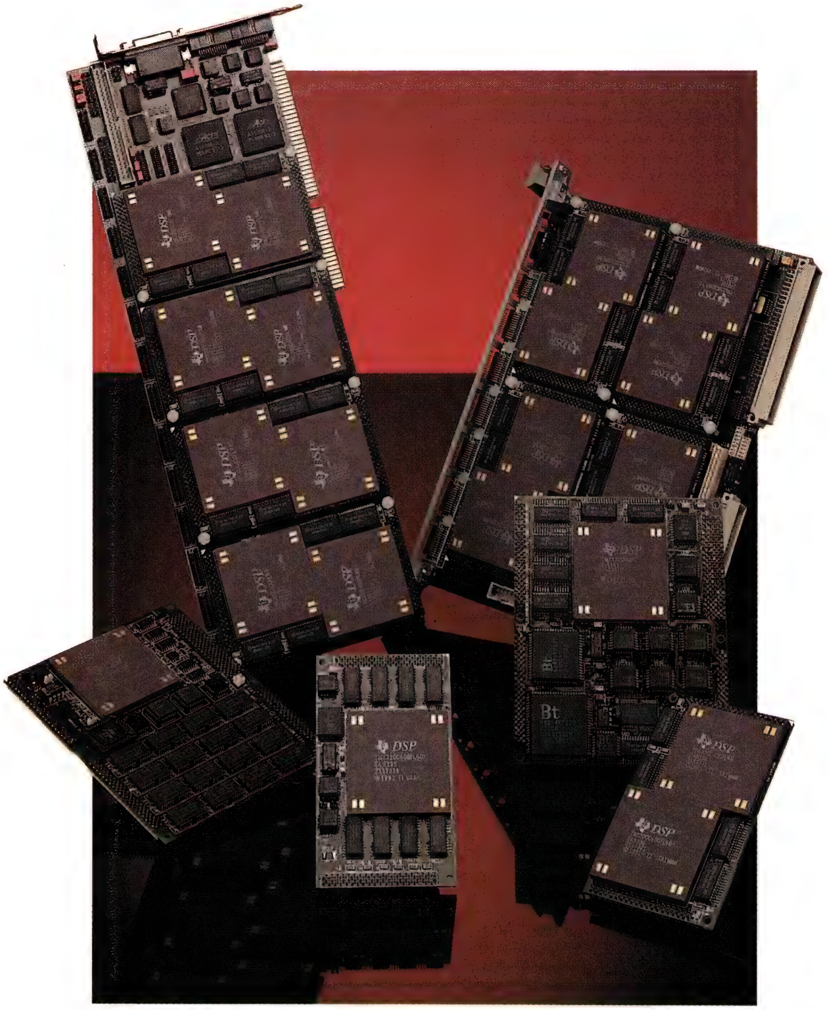

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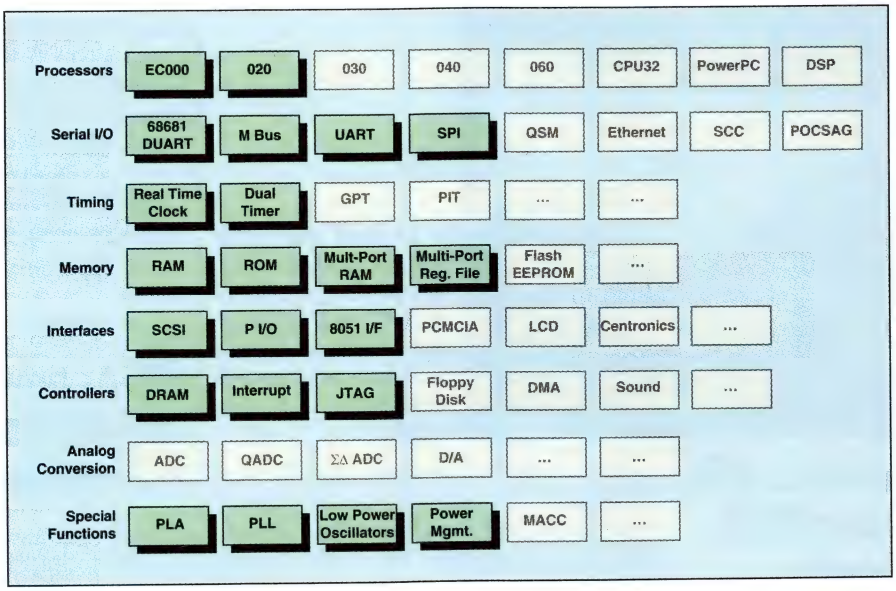
CIRCLE NO. 146

EDITED BY FRAN GRANVILLE

Embed 68000 µP cores into your ASIC

Motorola's FlexCore program lets you create ASICs by wrapping prebuilt functional logic blocks (macrocells) and custom logic around 32-bit CPU cores based on the 68000 µP family. For high-volume applications, this program allows you to create a proprietary µP IC that can reduce board size, minimize the number of component interconnections on the pc board, reduce system power consumption, and increase system reliability.



The FlexCore functional-block ASIC library includes two processor cores and a variety of peripheral and interface circuits. Additional blocks will follow. (Current blocks in the library appear in black; future blocks appear in gray.)

SunDisk Corp (Santa Clara, CA) and Digital Equipment Corp (Maynard, MA) are participating in this ASIC program. SunDisk will use a FlexCore ASIC to control its next-generation PCMCIA (Personal Computer Memory Card International Association) flash-memory card. Motorola delivered processors to SunDisk (for prototypes) 54 days after SunDisk completed the design and simulation for the ASIC. SunDisk will ship the flash-memory card in the second half of this year. DEC is using FlexCore parts in high-performance disk drives.

Motorola wants to team with partners willing to use FlexCore ASICs to bring proprietary technology to market as standard ICs through Motorola's sales and marketing organization. The recently announced 68322 µP is the first product of such a partnership—between Motorola and Peerless Systems Corp (El Segundo, CA). This standard part fuses a 68EC000 core and a raster graphics processor, designed by Peerless, to create a specialized processor for laser printers.

Currently, two CPU cores are available in the FlexCore program: the EC000 and the 020. Both CPUs are static designs and run on 5 or 3.3V. The EC000 core is an enhanced version of the 68000 and 68EC000 µPs. The processor core has a statically selectable 8- or 16-bit data bus. Enhancements include a 32-bit address bus (up from 24 bits on the µPs) and additional control signals that ease interfacing between the processor core and surrounding circuitry. The 020 core is a full 32-bit implementation of the 68000 architecture. It has a 256-byte instruction cache and a coprocessor interface. Motorola plans to add more core processors in the future, including the 030 core, based on the 68030 µP. The company plans that introduction for the fourth quarter of this year. Eventually, the entire 68000 family will be available as cores, as will members of the PowerPC µP family.

You add logic to these processor cores using cells from Motorola's HPF06 CMOS standard cell library, which includes 150 digital cells. HPF06 is a 0.65-µm, triple-level-metal process. HPF06 parts run on supply voltages ranging from 2.7 to 5.5V. Typical gate delay is 180 psec (with a fanout of 2). The cell library also contains large functional blocks including single-port and multiport RAMs, ROMs, register files, and peripheral blocks (see **fig**).

Currently, you must design FlexCore using one or more of the following tools: Cadence Framework, Verilog, Verifault, and Veritime; Viewlogic Powerview; and Synopsys' synthesis tool and test compiler. Motorola plans to add electronic-design-automation tools to that list. Prices vary from design to design but can dip below $10 (100,000). The 68322, for example, costs $17.95 (10,000). Typical NRE is $125,000.—by Steven H Leibson

Motorola Inc, Austin, TX, (512) 891-2134. **Circle No. 561**

CPU swap available for SPARCstations

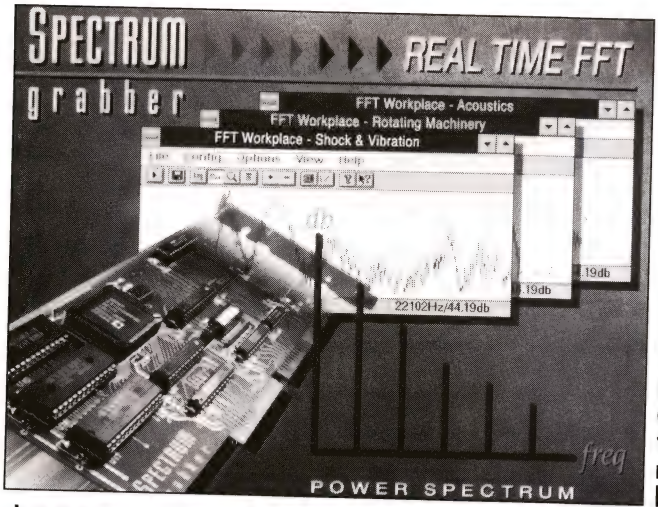
Users of the Sun SPARCstation 10 and SPARCserver 600MP computers can now upgrade their CPUs to 66-MHz devices. The upgrades, which are compliant with SPARC SCD 1.1, take advantage of the hyperSPARC design approach used in the two computers. That approach places the CPU and second-level cache into a removable module on the motherboard. Users simply unplug the existing module and insert the new one along with modified boot PROM.

The upgrade modules come in two processor speeds and in 1-, 2-, or 4-processor configurations. The recently introduced 66-MHz modules have prices ranging from $3490 to $11,960. Modules with 55-MHz CPUs, available since November 1993, now come with 20% lower prices: $2760 to $7960.

—by Richard A Quinnell

Ross Technology, Austin, TX, (512) 892-7802.

Circle No. 562


SPECTRUM
grabber
REAL TIME FFT
FFT Workplace - Acoustics
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db
22102Hz/44.19db
19db
19db
freq
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$395 card performs FFTs on data from any DMA ADC or DAC board

If you need to transform time-domain data from an ADC into its frequency-domain equivalent, you no longer have to wait for your PC's CPU and numeric coprocessor to crunch the data. You also do not have to replace your data-acquisition board with one that also includes a DSP µP. All you need is an ADC board that does DMA transfers and Dataq Instruments' $395 half-size ISA-bus DI-280 Spectrum Grabber board. The board can eavesdrop on 8- or 16-bit DMA transfers from the ADC to memory and produce a 1024-point FFT in 15 msec. The DI-280 can also perform the same function on data transferred directly from memory to a DAC board and works with data-acquisition boards from most vendors. With the DI-280, the vendor supplies a turnkey application program, FFT Workplace for Windows, that updates its power-spectrum display as often as 50 times/sec. This program works with all supported boards and provides 1-, 2-, and 4-times display magnification, selectable windowing, spectrum averaging, and precise cursor measurements. The program also includes a function library that works with C, Basic, or Pascal programs that you write and that run under DOS or Windows.

—by Dan Strassberg

Dataq Instruments, Akron, OH, (216) 668-1444. **Circle No. 563**

IC vendor strives to get word of boundary scan to wider audience

Texas Instruments has distributed more than 50,000 boards and software packages that demonstrate how you can simplify design verification, debug, and test of ASICs, modules, and boards by designing in accordance with the IEEE-1149.1 (JTAG) boundary-scan test standard. But the company is redoubling its efforts to get engineers to appreciate the advantages of incorporating testability features in new designs.

TI's approach is nothing short of a "full-court press" on the design community's indifference to testability. One of the new offerings is a $1295 scan board with accompanying software. The board connects to a PC's parallel port. According to Doug Kostlan, manager of TI's Test Technology Center, the board, which incorporates an ASIC specially designed for it, is much more than a demonstration vehicle for TI's testability products. The vendor hopes that it will become an industry standard for testability-tool benchmarking. The board includes faults that even TI's own tools can't diagnose. Kostlan says the inclusion of such faults shows that his company is not using the unit just to sell its own products.

The company's other new boundary-scan offerings include a 2-part, 74-minute videotape ($149), a $119 CD-ROM containing reference material on boundary scan (including the text of the IEEE-1149.1 and -1a standards), free demo software (which differs from the software distributed with the scan board), and a pair of 2-day workshops ($795 each) to be held in several US locations during the remainder of 1994. The instructor at both workshops is Richard Sedmak, president of Self-Test services.—by Dan Strassberg

Texas Instruments Inc, Dallas, TX, (214) 638-0333. (For information on the workshops only, (800) 336-5236, ext 3904.) **Circle No. 564**

FPGAs provide customizable logic for I/O and memory

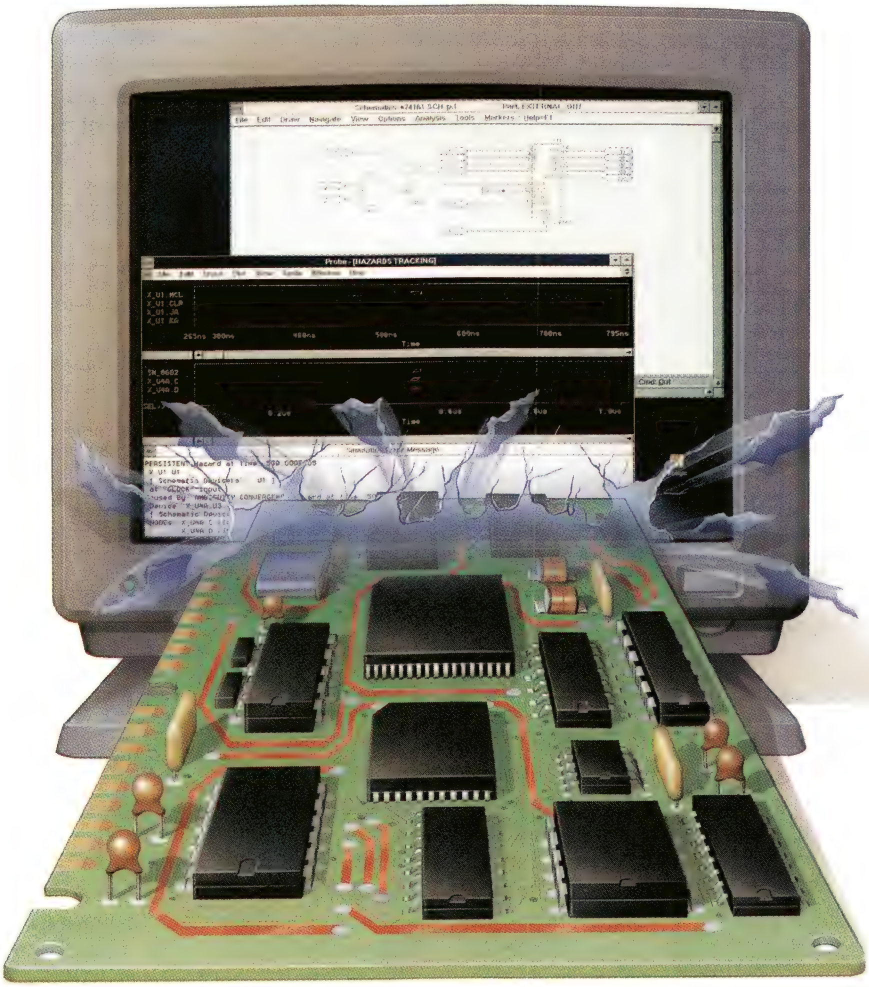
Intel Corp has added the iFX730 and iFX760 to its Flexlogic family of field-programmable gate arrays (FPGAs). The 730 uses a segmented architecture containing 30 macrocells arranged in three configurable function blocks (CFBs). The 760 also uses a segmented architecture containing 60 macrocells arranged in six CFBs. Both devices allow the use of each CFB as a block of 10-nsec, 24V10-like logic or a block of 15-nsec, 128×10-bit static RAM or EPROM. The 730 and 760 cost $15.38 and $30 (1000), respectively, in PLCC packages.—by John Gallant

Intel Corp, Santa Clara, CA, (800) 879-4683. **Circle No. 565**

Silicon transimpedance amp meets fiber-network specs

The AD8015 from Analog Devices meets the bandwidth, noise, and sensitivity specifications of 155-Mbps data links. Previous generations of silicon transimpedance amplifiers have been too slow for these high-speed applications, with typical bandwidths around 100 MHz, leaving GaAs devices as the only option. However, the 8015's 200-MHz bandwidth allows data rates of up to 300 Mbps NRZ. Total integrated rms noise from dc to 100 MHz is 20 nA, and sensitivity at 155 Mbps is –36 dBm. The amplifier's high gain coupled with its low noise allow receivers to detect weak input signals; the amplifier provides 2 dB of head room over SONET (Syn-

Finally...



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• CIRCLE NO. 150 FOR IBM • CIRCLE NO. 152 FOR SPARCSTATION

SHORTS

IEEE approves project to standardize radio-disturbance measurements. The IEEE has approved a project (P1385) for measuring 800-MHz to 40-GHz RF disturbances. Such disturbances can interfere with personal-communications-service (PCS) systems. The P1385 group will develop a practical procedure and appropriate instrumentation for measuring frequency, amplitude, and bandwidth of radio noise and will identify the maximum permissible field-disturbance levels for wireless PCSs. P1385, which will meet in May, seeks volunteers with expertise in PCS, electromagnetic-compatibility issues, and RFI to perform documentation, analysis, and instrumentation. AT&T Bell Laboratories, Holmdel, NJ, (908) 834-1800. **Circle No. 570**

Industry and government effort will develop power building blocks. The Clinton administration's Technology Reinvestment Project has awarded a grant to Harris Semiconductor and the Electric Power Research Institute. The grant enables the two organizations to develop power-electronic building blocks incorporating Harris' MOS-controlled thyristors (MCTs). Under the grant, the two will focus on process, package, and drive technologies. Much of the effort will address enhancements to Harris' MCTs, which can carry two to three times more current than can insulated-gate bipolar transistors, MOSFETs, and bipolar Darlingtons in the same die size. The companies expect the MCTs to serve as key elements in the building blocks. Harris Semiconductor, Melbourne, FL, (800) 442- 7747. **Circle No. 571**

Electric Power Research Institute, Palo Alto, CA, (415) 855-2413. **Circle No. 572**

PowerPC price plunges. Motorola's RISC Processor Division has reduced the price of its PowerPC 601 by 15%. The new prices are $238 (50 MHz), $318 (66 MHz), and $425 (80 MHz) (20,000). Motorola Inc, Phoenix, AZ, (602) 952-3000. **Circle No. 573**

chronous Optical Network) OC-3 specifications and 5 dB over FDDI (Fiber Distributed Data Interface) requirements. This head room prevents losses, which the receiver can never recover, in the transimpedance stage.

Also, highly sensitive gain stages traditionally have limited dynamic range and become overloaded in the presence of a strong input signal. The AD8015 can cope with peak input currents of 250 μA. The $3.10 (1000) amplifier is available in an 8-pin SOIC and as unpackaged die. The part requires a single 5V supply and draws 25 mA.

—by Anne Watson Swager

Analog Devices Inc, Wilmington, MA, (617) 937-1428. **Circle No. 566**

RISC+microcode= fast CISC emulation

While RISC processors hold the performance edge, CISC (complex-instruction-set-computer) processors continue to dominate the market for shrink-wrapped applications software. Emulation-software packages allow some CISC-hosted application software to run on RISC-based computers, but these software-based emulators generally suffer from slow—sometimes painfully slow—performance. International Meta Systems (IMS) developed emulation technology that finesses the speed problem by adding emulation circuitry and microcode ROM to a RISC CPU.

The resulting μP, a demonstration vehicle called the IMS 3250, is a 90-MIPS RISC processor with hardware emulation of both the Intel 486 and Motorola 68040 μP instruction sets. Thus, one processor can run IBM PC, Apple Macintosh, and its own native-mode RISC software. Rather than sell μPs as a merchant vendor, IMS is seeking OEM and semiconductor partners interested in exploiting its emulation technology.

The IMS 3250 design requires fewer than 700,000 transistors. The processor's emulation microcode resides in two on-chip 6k×32-bit-word microcode ROMs. In addition, the μP includes a memory-management unit, a dynamic-RAM controller, and the 90-MIPS RISC processor. The same emulation technology works on existing RISC processors, allowing them to run CISC-hosted code directly with a modest 5% increase in on-chip logic.

IMS devoted a significant part of its research to developing emulation techniques that allow the decoding and executing of register-to-register operations in one clock cycle. The result is very fast emulation. Because these techniques also work with superscalar RISC processors, processors incorporating IMS technology can conceivably emulate some CISC instructions in less than one clock cycle.

IMS began in 1986 as a spin-off of a research project at The Aerospace Corp, a federal-contract research center. The original goal of the project was to reduce the cost of software development by running very high-level languages on virtual machines.

—by Steven H Leibson

International Meta Systems Inc, Torrance, CA, (310) 375-4700. **Circle No. 567**

ARM software developers get a leg up

In support of its ARM 32-bit RISC processor core, VLSI Technology has created a graphical framework that simplifies the use of Advanced RISC Machines (ARM) development tools. The framework, called JumpStart, allows developers to use a mix of C- and assembly-language code and provides symbolic debugging. The debugging software allows you to create browse windows for editing code or examining code behavior at several points in the program simultaneously. The software also lets you perform conditional stepping and to back-trace in predefined performance windows to assist in code optimization. Further, its documentation is available on-line via hypertext links, so that you can retrieve relevant documents during a debugging session.

The JumpStart framework offers an instruction-set emulator for simulating target systems and an ANSI C compiler, an assembler, and a linker along with the debugger. It is currently available for Sun and Hewlett-Packard workstations; DOS/Windows versions are in development. Software licenses cost $3000 (quantity discounts available).—by Richard A Quinnell

VLSI Technology Inc, San Jose, CA, (602) 752-6373. **Circle No. 568**

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CIRCLE NO. 134

SHORTS

Faster, cooler PowerPC appears. IBM and Motorola have announced an improved version of the PowerPC 601 µP. The improvements boost the device's clock rate from 66 to 100 MHz and drop power consumption from 8 to 4W. IBM Microelectronics Inc, Fishkill, NY, (800) 426-0181. **Circle No. 574**

Motorola Inc, Austin, TX, (512) 891-2000. **Circle No. 575**

Today's Paul Revere: One if by land, two if by sea, three if by a wire transfer, four for answers to commonly asked questions, or zero for an operator. Newstips, Novelty, OH, (216) 338-8400. **Circle No. 576**

Debut for MPEG developer's kit. AuraVision Corp has introduced a developer's kit for creating low-cost MPEG-playback PC add-in cards based on the VxP500 video processor and the C-Cube CL450. The kit includes a reference design board and royalty-free source code. AuraVision Corp, Fremont, CA, (510) 440-7180. **Circle No. 577**

MCC project receives federal funding. The Enterprise Integration Network (EINet), Microelectronics and Computer Technology Corp's electronic communications system, will provide the primary network-services foundation for three projects selected to receive awards under the federal Technology Reinvestment Program. EINet allows industry-specific applications to interconnect transparently over the Internet information service and provides directory, information, and security services. Microelectronics and Computer Technology Corp, Austin, TX, (512) 343-0978. **Circle No. 578**

University program features i-Logix products. In an effort to provide engineering students with hands-on experience, i-Logix is offering a $1000/year university program. Universities that buy the program get i-Logix's ExpressV-HDL and Statemate electronic-system-design-automation tools, a seat in scheduled training classes at the company's Andover, MA, headquarters, product upgrades, and a network license with a maximum of 20 concurrent users. i-Logix Inc, Andover, MA, (508) 682-2100. **Circle No. 579**

ARPA grants network contract to MCC. The Advanced Research Projects Agency (ARPA) has granted a $9.76 million contract to Microelectronics and Computer Technology Corp to develop and implement an agile manufacturing information infrastructure (AMII). AMII will feature such services as network security and directories, distributed-design tools, concurrent-design services, and distributed-parts catalogs. Microelectronics Computer Technology Corp, Austin, TX, (512) 343-0978. **Circle No. 580**

Softaid releases application guides. These free guides address various aspects of debugging embedded systems. "Hardware Breakpoints" discusses how breakpoints work and tradeoffs in their use. "Single Stepping in ISRs" provides methods of debugging time-critical sections of code. "Prefetchers" describes how modern processors' bus cycles can confuse debuggers and suggests how to make sense of the data they provide. Softaid Inc, Columbia, MD, (410) 290-7760. **Circle No. 320**

Vicor offers power-components catalog. This free, 36-pg color catalog details the vendor's component and configurable power products. It includes specifications, applications data, selection charts, and prices. Vicor Corp, Andover, MA, (800) 735-6200. **Circle No. 358**

OTA reviews technologies behind mass-destruction weapons. The Office of Technology Assessment (OTA) reviews the technical requirements to develop and build nuclear, chemical, and biological weapons, along with the systems most capable of delivering them to targets—ballistic missilies, combat aircraft, and cruise missiles. Copies of the 264-pg *Technologies Underlying Weapons of Mass Destruction* are available for $15. US Government Printing Office, Box 371954, Pittsburgh, PA, (202) 783-3238. **Circle No. 421**

Motorola cuts pressure-sensor prices. Motorola has lowered prices by an average of 71% on a wide range of pressure sensors. For example, the 100-kPa differential MPX100D goes from $13.50 to $4.38 (100), and the 50-kPa integrated MPX5050D and MPX5100D sensors go from $38.42 to $11.05 (100). Motorola Inc, Semiconductor Products Sector, Phoenix, AZ, (602) 952-3000. **Circle No. 483**

Study reveals 6-way split in attitudes toward technology

Marketers of interactive television and other new media products and services may damage the very market they are trying to build, according to a study by market researcher Odyssey. The survey of more than 4000 consumers in 13 states reveals six diverse attitudes toward current and emerging technologies. As a result, says Odyssey, marketers should be targeting six markets rather than one when selling new products such as interactive TV.

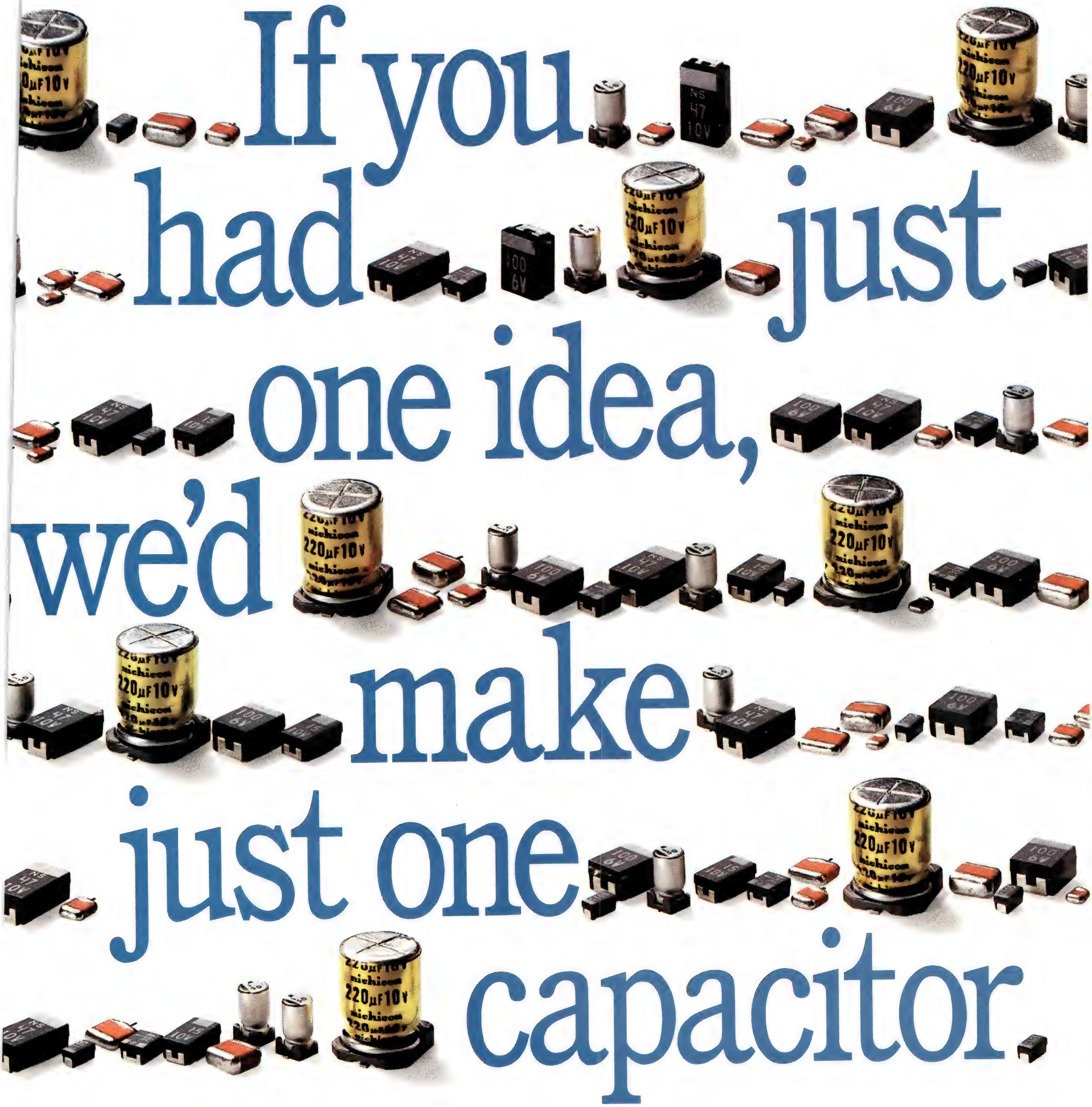
The company asked consumers what they expect to get out of a technology, how they feel about the learning process they have to go through to master a technology, how much they are willing to pay for a new product, and similar questions. The results of the survey define the following six attitudinal market segments:

- New enthusiasts, who have a strong desire to learn and master new technologies, who demand high performance, and who have the means to pay a premium for the latest technology
- Hopefuls, who, like new enthusiasts, want to learn new technologies but who lack either the education to master those technologies or the means to pay for them
- Faithfuls, who are neither excited by nor averse to new technologies
- Oldliners, who are not interested in new technologies and are concerned about the cost of the latest products and services
- Independents, who can afford to pay for new technology but are not interested in improving current offerings
- Surfers, who are ambivalent about new technologies and are able to pay for them but are suspicious of large corporations that might offer it.

—by Fran Granville

Odyssey Ventures Inc, San Francisco, CA, (800) 742-1792.

Circle No. 569



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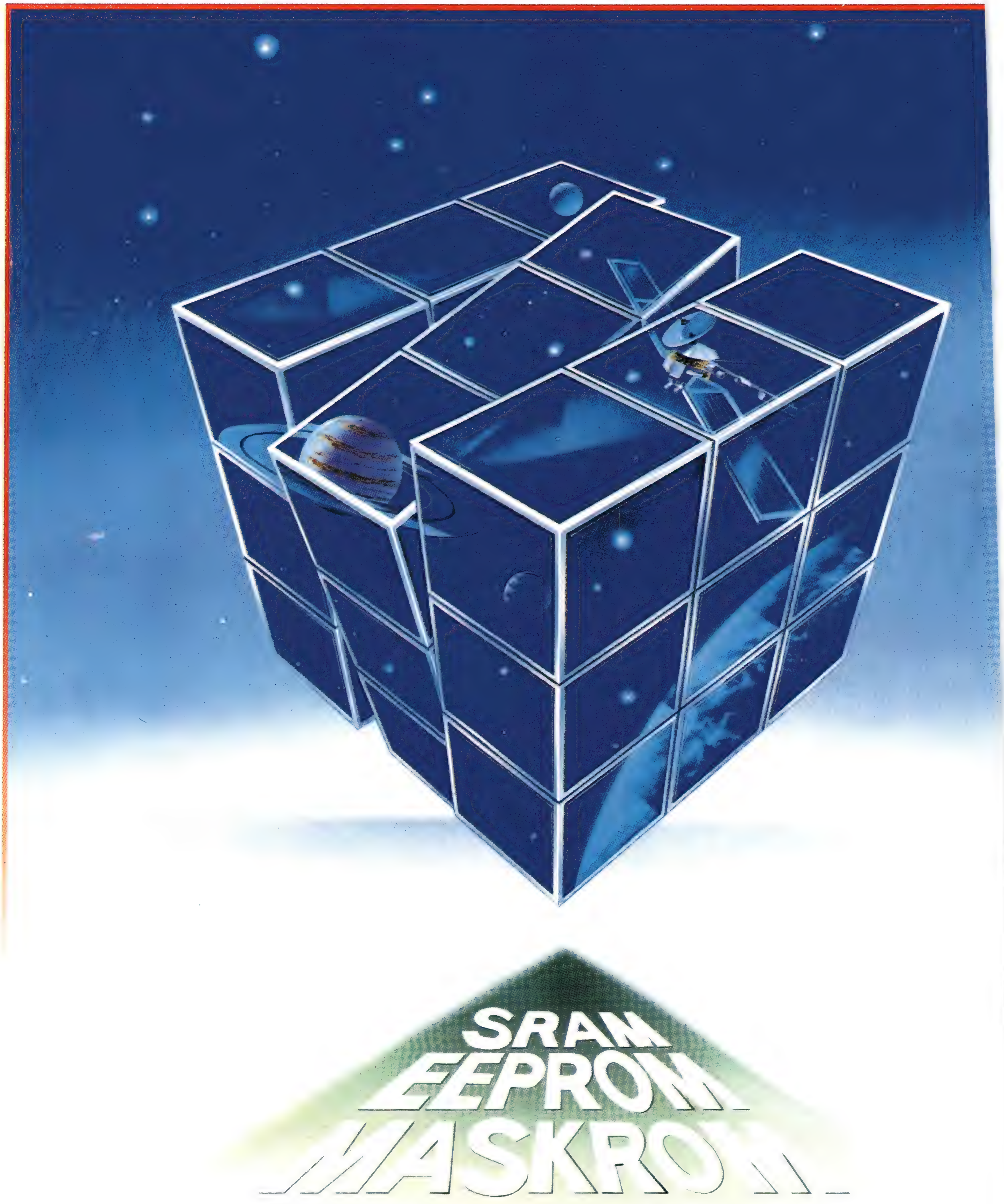

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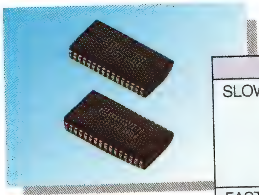
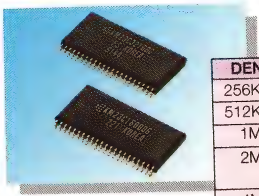


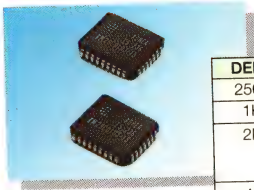
SRAM

	DENSITY	ORG.	SPEED	PKG	REMARK
SLOW	64K	X8	70/100/120	28DIP/SOP, 28SDIP	
	256K	X8	(55)/70/85/100/120	28DIP/SOP, 28TSOP (I)	55ns, 3.0V:2Q'94
	512K	X8	55/70/100	32SOP, 32TSOP (I)	
	1M	X8	55/70/85/100/120	32DIP/SOP, 32TSOP(I)	3.0V:2Q '94
	4M	X8	45/55/70/100	32DIP/SOP, 32TSOP (II)	3.0V AVAILABLE
FAST	64K	X4	15/20/25	22DIP, 24SOJ	
		X8	15/20/25	28DIP/SOJ	
	256K	X4, X8	6/7/8 (BiCMOS)	28, 32SOJ	CENTER PWR
		X4, X8	8/10/12 (BiCMOS)	28SOJ	CORNER PWR
		X4, X8	(12)/15/20/25	28SOJ	12ns:2Q '94 3.3V/15ns:3Q '94
	288K	X9	9/10/12 (BiCMOS)	32SOJ	
	4M	X4, X8	20/25	32SOJ, 36SOJ	
		X16	20/25	44SOJ	
	1M	X4, X8	8/9/10/12 (BiCMOS)	32SOJ	
		X4, X8	20/25/35	28DIP/SOJ, 32DIP/SOJ	CORNER PWR
		X4, X8	15/20	32SOJ	CENTER PWR
		X16	15/17/20	44SOJ	CENTER PWR
SPECIALTY	1M	64KX18 (S.B)	8/9/10/12	52PLCC	P5 CACHE
		256KX4 (S.P)	10/12.5	36SOJ	MIPS R 4000/R 4400



MASK ROM

DENSITY	PART NO.	ORGANIZATION	SPEED(ns)	PACKAGE
256K BIT	KM23C256X	32K X 8	120/150	28DIP/32SOP
512K BIT	KM23C512X	64K X 8	120/150	28SIP/32SOP
1M BIT	KM23C10XX SERIES	128K X 8	120/150	28DIP/32DIP/32SOP
2M BIT	KM23C2X0X SERIES	256K X 8 126K X 16	100/120	32DIP/32SOP/40DIP
4M BIT	KM23X4X0X SERIES	512K X 8 256K X 16	100/120/150	32DIP/32SOP/40DIP/40SOP
8M BIT	KM23X8X0X SERIES	1M X 8 512K X 16	100/120	32DIP/32SOP/42DIP/44SOP
16M BIT	KM23X16X0X SERIES	2M X 8 1M X 16	120/150	42DIP/44SOP/36DIP
32M BIT	KM23C32X0X SERIES	4M X 8 2M X 16	150/200	42DIP/44SOP/70SSOP



EEPROM/FLASH

DENSITY	PART NO.	ORGANIZATION	SPEED(ns)	PACKAGE
256 BIT	KM93C06/07	16 X 16	1 MHz	8DIP/8SOP
1K BIT	KM93C46 SERIES	64 X 16	1 MHz	8DIP/8SOP
2K BIT	KM93C56 SERIES KM93C57 SERIES	128 X 16 128 X 16 256 X 8	1 MHz 1 MHz 1 MHz	8DIP/8SOP 8DIP/8SOP 8DIP/8SOP
4K BIT	KM93C66 SERIES KM93C67 SERIES	256 X 16 256 X 16 512 X 8	1 MHz 1 MHz 1 MHz	8DIP/8SOP 8DIP/8SOP 8DIP/8SOP
	KM28C16/J/I KM28C17/J/I	2K X 8 2K X 8	150/200/250 150/200/250	24DIP/32PLCC 28DIP/32PLCC
64K BIT	KM28C64A SERIES KM28C65A SERIES	8K X 8 8K X 8	120/150/200 120/150/200	28DIP/32PLCC 28DIP/32PLCC
1M BIT	KM29C010/J/T	128K X 8	100/120/150	32DIP/PLCC/TSOP
16M BIT	KM29N16000T	2M X 8	80	44(40)TSOP (II)

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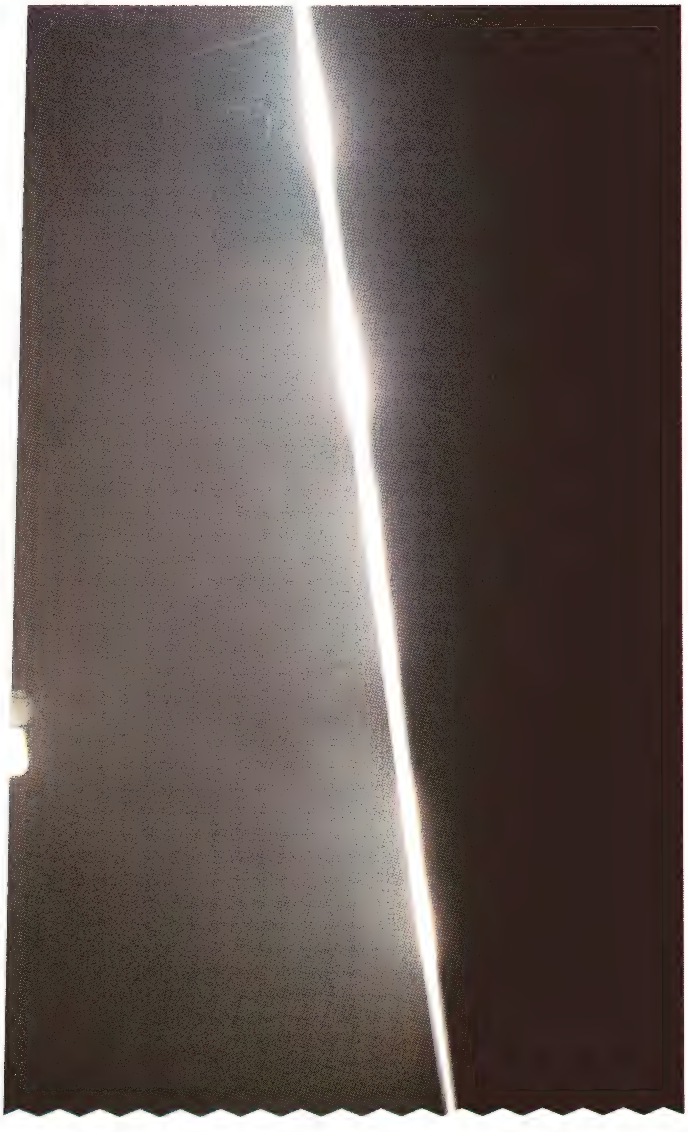

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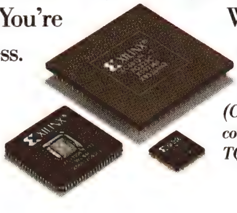

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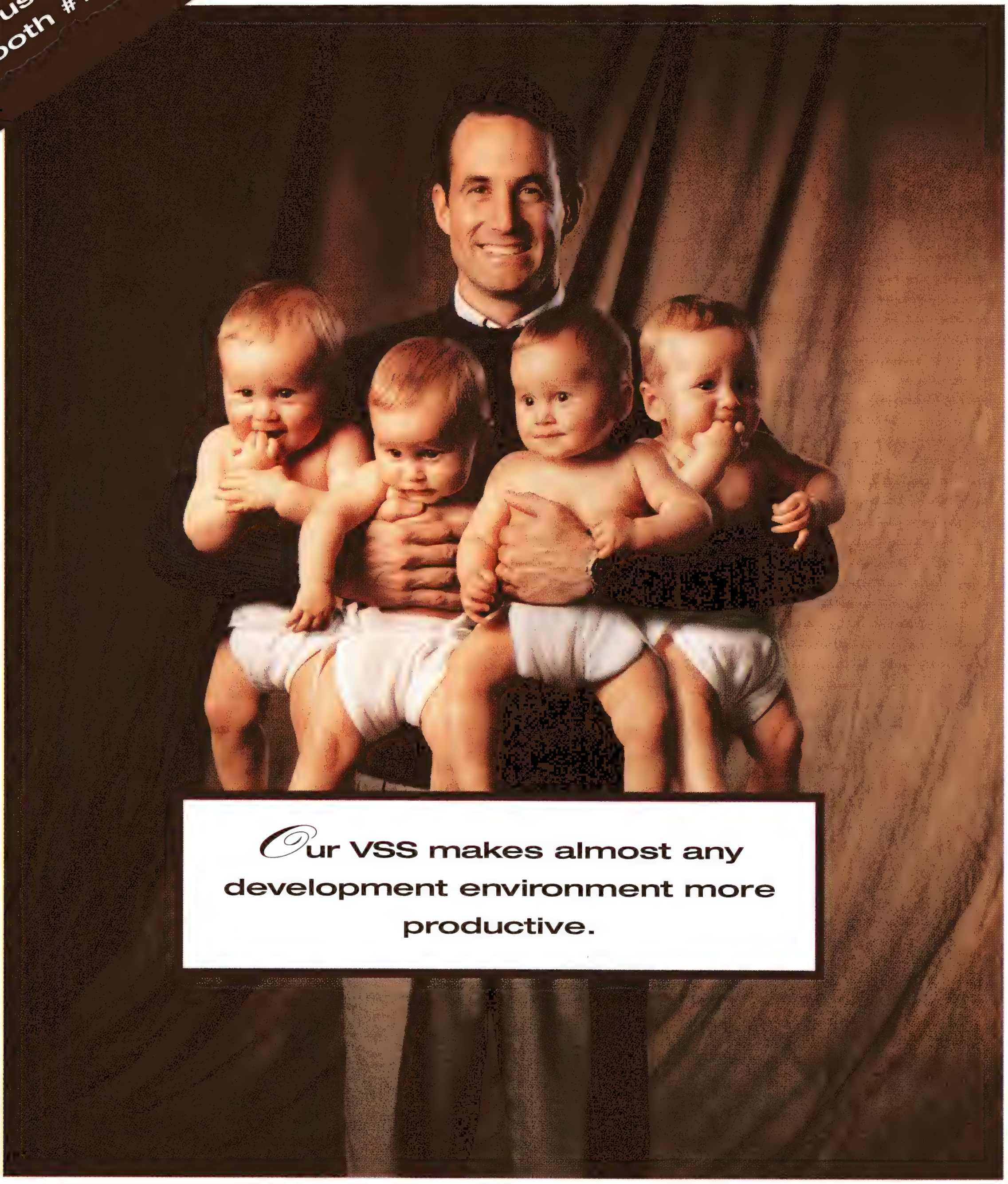
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Corrections and addenda

The box in Gary Legg's "PCI local bus gathers momentum" (February 3, 1994, pg 25) contains a misleading statement in comparing the VL (VESA local) bus and the PCI (Peripheral Component Interconnect) bus. It states: "PCI cards are more adaptable to different types of systems, however. A PCI card works in any ISA-, EISA-, or MicroChannel (MC)-based system that also has PCI slots; VL-bus cards have both a VL connector and an ISA, EISA, or MC connector, so they're limited to only one type of system."

A straight technical read of the VL-bus 2.0 specification without regard to the dynamics of the PC marketplace would lead to the assertion stated above. However, I have not yet seen even one VL-bus card with anything other than the combination of VL and ISA connectors. There is little to gain from a VL-EISA card compared with a VL-ISA card, and the horrific disadvantage of a VL-EISA card is that there are far fewer VL-EISA motherboards than VL-ISA motherboards. And a VL-bus card with an ISA-bus connector installs and operates just fine in a system with VL-EISA slots. Although the VL-bus 2.0 spec shows a combination VL-MCA connector layout, MC appears not to be a factor in the high-volume add-in card market for PC hardware.

So the bottom line is a simple one: If a motherboard has an available PCI slot, a PCI board ought to install and operate in it. If a motherboard has an available VL slot (with a companion ISA or EISA slot), a VL board ought to install and operate in it.

Ben Myers
Spirit of Performance Inc
Harvard, MA

Senior Technical Editor Gary Legg responds: Myers' point about the computer marketplace is well-taken. Most of the possible combinations of the VL bus with the various system buses don't exist. Myers is also correct in stating that a VL-ISA card works in a VL-EISA motherboard. So, yes, it's true: Any existing VL card works in any existing VL motherboard.

If you're designing a new VL-bus product, though, just be aware that you can—theoretically, at least—run into compatibility problems. With three possible connector combinations on VL-bus cards and the same three combinations on motherboards, you get nine possible card-motherboard combinations, only four of which work together. A PCI card, on the other hand, has only one connector, so any PCI card works in any PCI slot.

By the way, I failed to include an address for the PCI Special Interest Group in my article. You can reach the group at (503) 696-6111.

Bloopers and bungles

Gremlins struck our Microprocessors new-product section in the March 31, 1994, issue (pg 67). The writeup for Motorola's new dual-processor µP for printers, which combines a 68EC000 core CPU with a specialized RISC graphics processor, has an incorrect part no. and an incorrect phone number. The correct part no. is 68322; for more information on this product, phone Motorola at (512) 891-2154.

C-Quad City

I was amused by Steve Leibson's editorial, "Harmonious convergence" (March 17, 1994, pg 23). The following is an idea I've been using for about a year at our company:

C^4E^2: convergence of computing, communications, consumer electronics, and entertainment.

Sunil B Phatak, PhD
Market Operations Manager
AT&T Microelectronics
Breinigsville, PA

Regarding Steven Leibson's editorial, "Harmonious convergence" (March 17, 1994, pg 23), I concur with your "C-Quad." However, with respect to Reason 9 (military heritage):

- C^2 is indeed Command and Control, but
- C^3 is Command, Control, and Communications, and
- C^4 is Command, Control, Communications, and Computers.

Also, how about C^3I and C^4I, where I stands for Intelligence (as in the CIA, DIA, AFIA, and other agencies). I even once suggested a C^5I^2BM for Command, Control, Communications, Computers,

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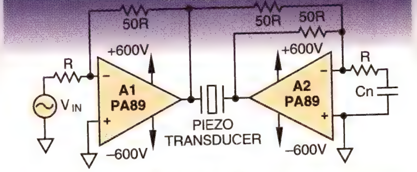

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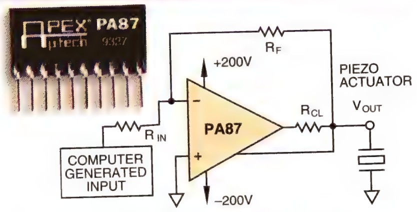

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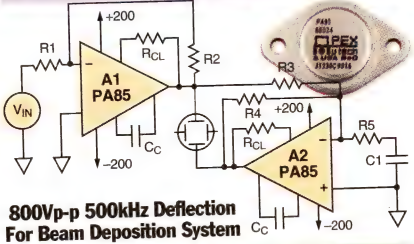

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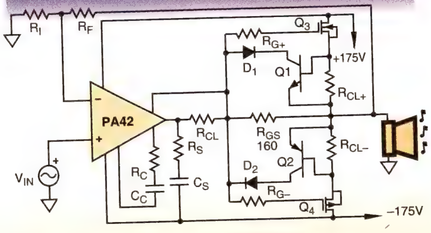

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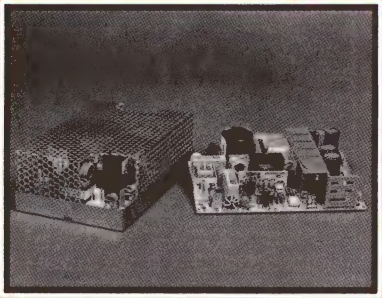

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Countermeasures, Intelligence, Interoperability, and Battle Management. No one adopted my suggestion. Is it a bit much?

Tom S Reyenga
OC-ALC/LASKA
Tinker AFB, OK

I have never written a response to one of these engineering magazines, but after reading Steve Leibson's editorial (March 17, 1994, pg 23), I figured, "What the hell? I can have a little fun with this one!"

Here are my top-10 reasons for *not* adopting the name "C-Quad":

3. The 4D aspect is that people will hate the term "C-Quad" up to 4 times as much as they hate typical garden-variety acronyms for the computing world.
8. It vaguely reminds me of "C-section," which is not a pleasant thought.
1. The First Lady cannot use it in the near term for the new health-care plan.
6. It's cryptic enough that everyone will forget what it actually means. More important, no one will care what it means.
5. David Letterman would hate it.
4. Dilbert and Dogbert would hate it, too.
7. Unlike WYSIWYG, it's just not fun to say it.
2. I live in Boulder, CO, but I was in Malibu, CA, for the harmonic convergence. I am by no means an expert on convergence but still think that "C-Quad" sounds weak.
9. If it has anything to do with the military, nobody wants to be associated with it.
0. It's a short, 2-syllable word that makes you sound like a geek!

By the way, anyone know why I selected the order 3816547290?

Michael Benson
Fujitsu Computer Products of America
Boulder, CO

Sound off

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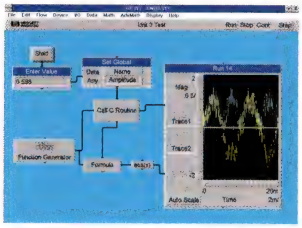

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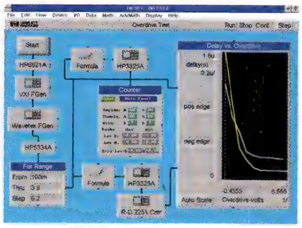

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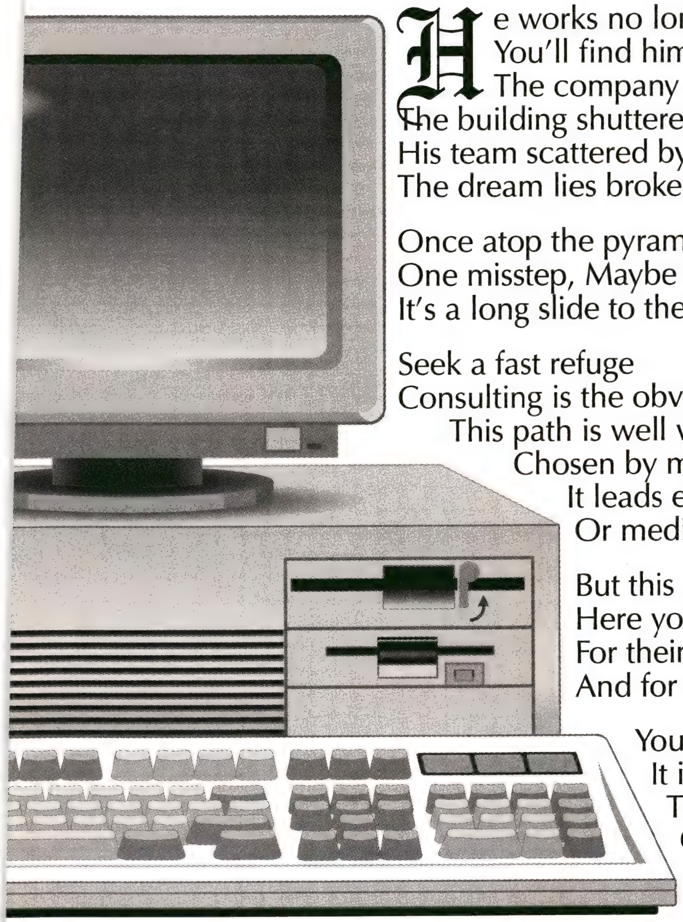

He works no longer in this city
You'll find him far from here
The company he founded is dark
The building shuttered
His team scattered by the winds of change
The dream lies broken in the rubble

Once atop the pyramid
One misstep, Maybe two
It's a long slide to the bottom

Seek a fast refuge
Consulting is the obvious route
This path is well worn
Chosen by many before him
It leads either to salvation
Or mediocrity; Or both

But this is not the way to build dreams
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And for your own sustenance

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The drive to create renews itself
Creativity finds its own path

He dreams anew

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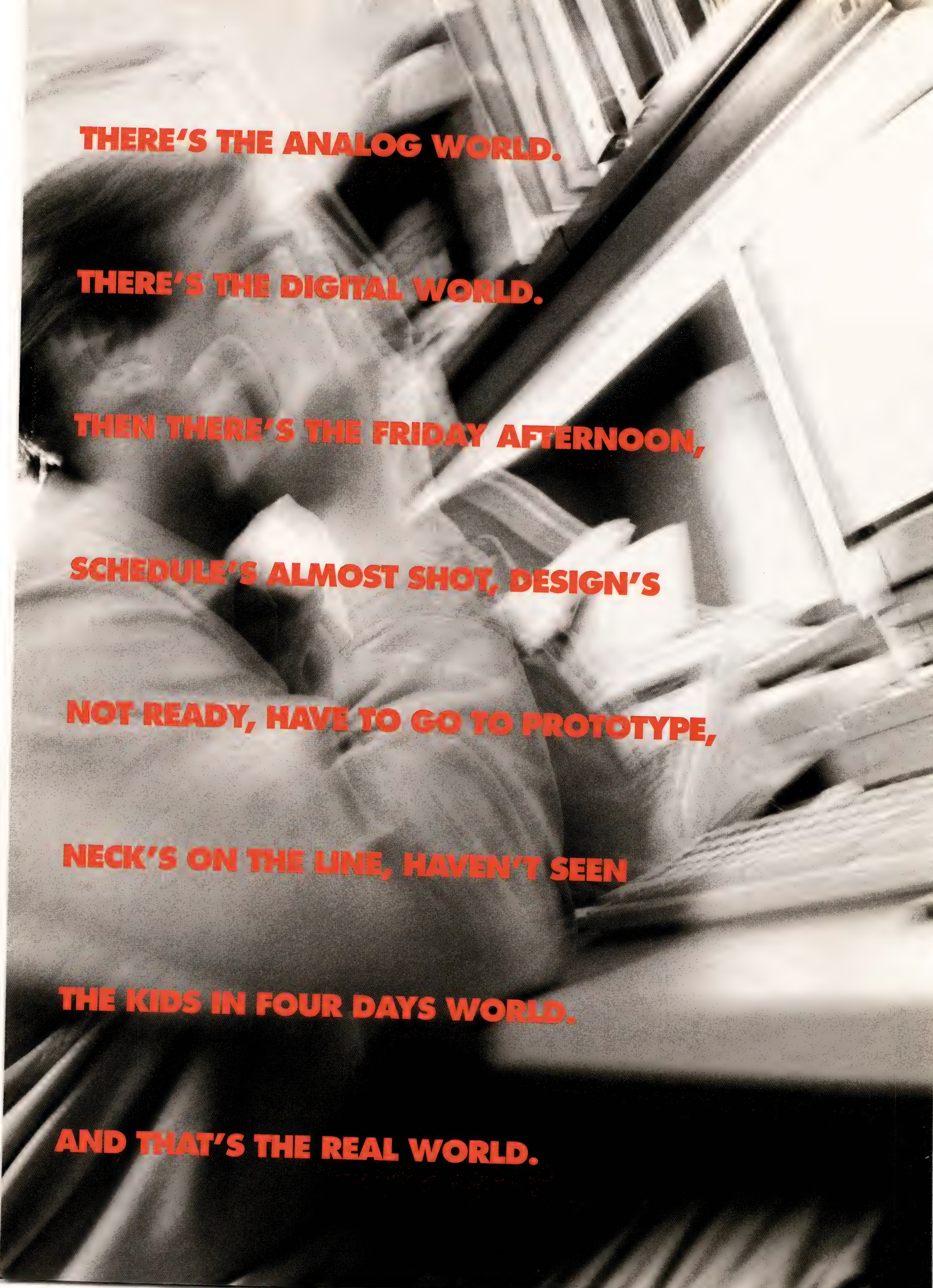
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Ask EDN

EDITED BY JAMES P LEONARD

Any advice on good microphones?

I am trying to locate a manufacturer or distributor of high-quality tape-recorder-sized electret microphones. Any advice?

Steve Swanson
Salt Lake City, UT

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- CUI Stack Inc
  (Beaverton, OR)
  (503) 643-4899
- International Microelectronics
  (Arlington, TX)
  (817) 473-1730
- JEMA
  (Wilmette, IL)
  (708) 251-3600
- Shogyo International Corp
  (Great Neck, NY)
  (516) 466-0911.

More help for parts search

After reading "Ask EDN" for a year, our company has noted the difficulty your readers are experiencing in obtaining electronic components in small quantities in the United States. Our company is a UK-based mail-order company that specializes in providing electronic components in small quantities. The minimum order is $25. Unfortunately, however, we cannot forward price lists or catalogs because of the range of components we supply. Please contact us with your specific requirements, and we'll forward relevant price lists.

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Seeking semicustom-BIOS suppliers

We need to incorporate a semicustom BIOS (that is, not off-the-shelf) in our DOS-compatible product. Although we already have documentation from Phoenix, we cannot obtain the coordinates of any other BIOS manufacturer to evaluate the differences between competitors. Would you have contact information for any of them?

Philippe Lebourg
aptor systemes de communication
Meylan, France

In addition to AMI, Oak Tech, and ATI, contact the following:

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  Greer, SC 29650
  (803) 877-8700
- Datalight
  307 N Olympic Ave, Suite 201
  Arlington, WA 98223
  (206) 486-8086
  fax (206) 435-0253
- DOSystems Inc
  Box 4601
  Carmel, CA 93921
  (408) 625-9016
- Intel Corp
  Box 58119
  Santa Clara, CA 95052
  (800) 548-4725
  (408) 765-8080
- Logical Design Group Inc
  6301 Chapel Hill Rd
  Raleigh, NC 27607
  (919) 851-1101
  fax (919) 851-2844
- Microsoft
  1 Microsoft Way
  Redmond, WA 98052
  (206) 882-8080
- Pro-Log Co
  12 Upper Ragsdale Dr
  Monterey, CA 93940
  (408) 372-4593
- WinSystems Inc
  715 Stadium Dr, #100
  Arlington, TX 76011
  (817) 274-7553
- Ziatech
  3433 Roberto Ct
  San Luis Obispo, CA 93401
  (805) 541-0488
  fax (805) 541-5088.

Far East quest for extender cable

I am working on speeding a 286 PLCC computer with a passive backplane. I am replacing the 286 CPU with a very small 486 board, but the space left is too small. I would like to locate an extender cable for PLCC to PLCC of approximately 3 in. (Tektronix makes one for LCC to PLCC (nr.C24850)). Any other ideas?

Rob Oudendijk
Chief Engineer at Birdland
Shibuya-ku, Tokyo, Japan

Contact ITT Pomona Electronics (Pomona, CA) at (909) 623-3463, fax (909) 629-3317 or Emulation Technology (Santa Clara, CA) at (408) 982-0660, fax (408) 982-0664.

Paper overload slows search for schematic

I restore old physics and electronic instruments. One instrument recently showed up that seems to merit restoration, but I need help. The device is a Hewlett-Packard Model 400C RMS voltmeter. I need a power transformer and a schematic; our in-house repair facility no longer keeps old schematics or operating manuals—because of "paper overloads." Any of your readers have advice?

William Quam
EC&G/EM
Goleta, CA

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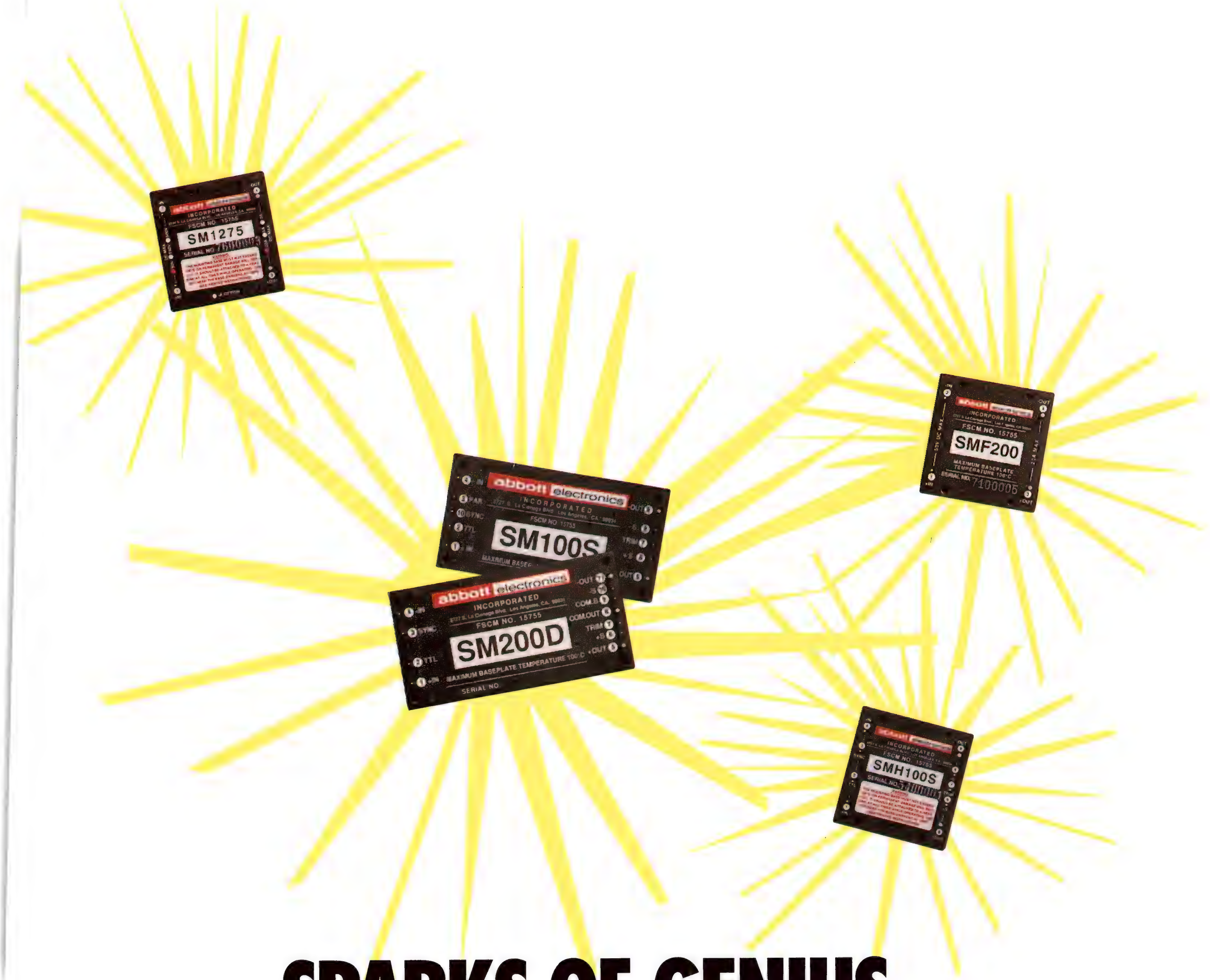

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INPUT VOLTAGE (VDC)	16-50 and 200-400				Mil-STD-1275A Mil-STD-704A
OUTPUT VOLTAGE (VDC)	2, 3.3, 5, 5.2,12, 15, 24, 28		±5, ±12, ±15	—	—

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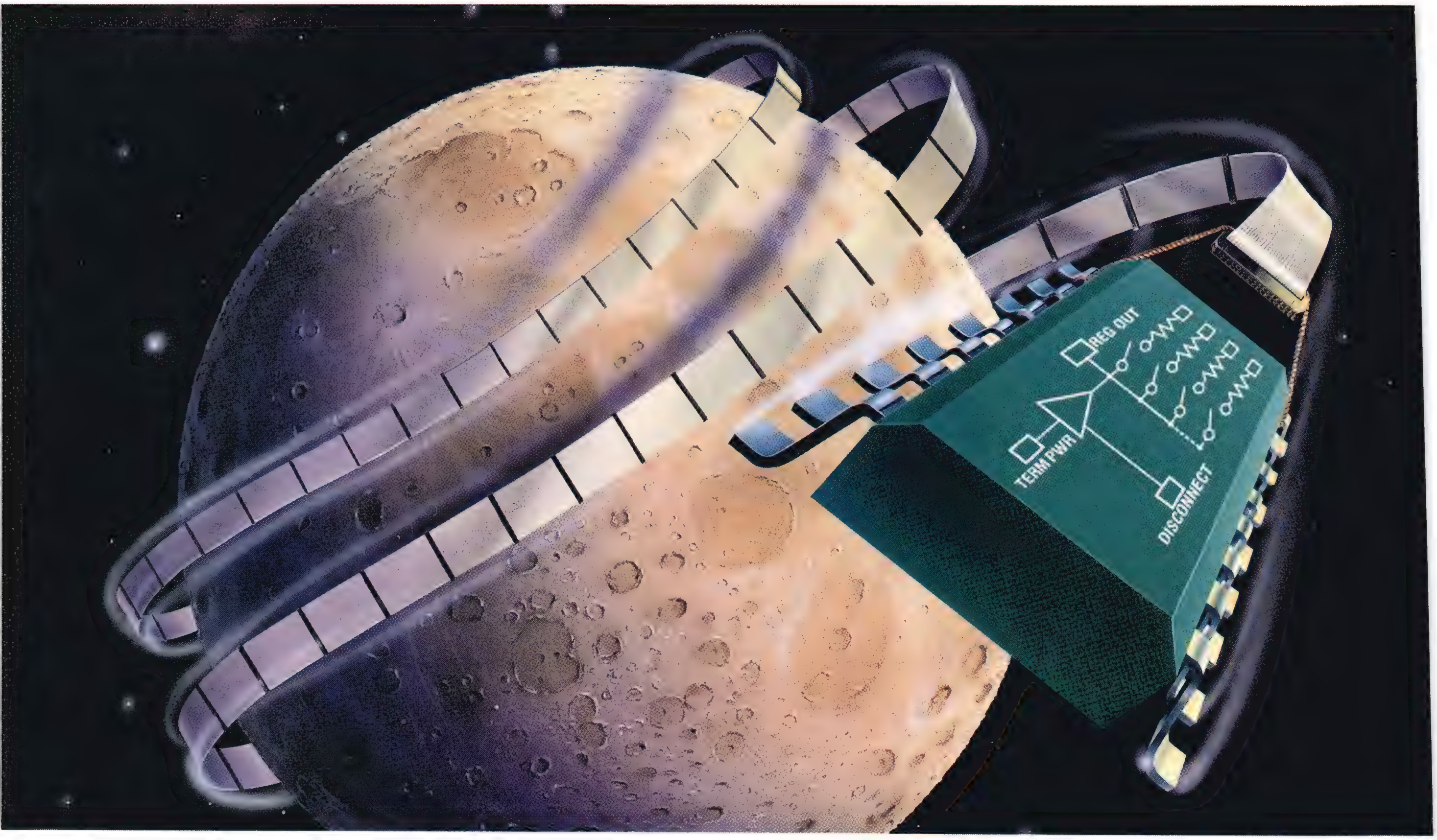

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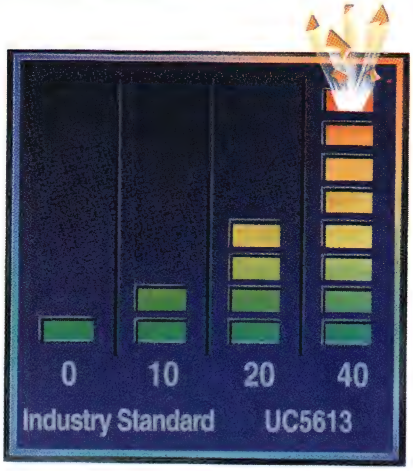

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Diverse PCMCIA add-ons present difficult choices

GARY LEGG, Senior Technical Editor

Abundant, inexpensive PCMCIA card drives make it easy to add credit-card-sized peripherals to desktop computers and embedded systems. But finding the right drive for your application isn't so easy.

Adding PCMCIA (Personal Computer Memory Card International Association) card slots to a desktop computer or an embedded system is pretty easy. You just plug in one of the scores of different add-in and add-on PCMCIA card drives that have recently become available. Most of the drives are for PCs, but you can also find units for VME, STD, and PC/104 systems. Prices begin at under $300.

Making sure a card drive will operate all the different types of PCMCIA cards is not so easy, however. The numerous available drives have different numbers of slots, different slot sizes, and widely varying support for the many different types of PCMCIA cards. And a few drives, according to word-of-mouth reports, are plagued with noise problems and aren't reliable.

The majority of PCMCIA card drives will do everything you want them to. They accept cards of the three standard thicknesses and possibly a fourth nonstandard thickness. They come with system software that operates any kind of PCMCIA device—a memory card, a hard disk, a LAN adapter, and more. They are well designed and have been adequately tested for reliable operation.

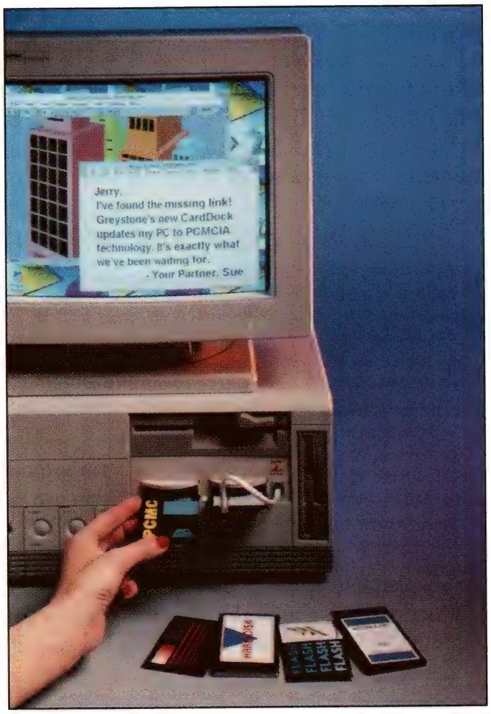
But some card drives do have limitations, some of which may be important to you and some of which may not. For example, some drives will operate memory cards or hard-disk cards, but not other peripheral cards. Some drives may not support flash-memory cards. Most drives for PCs allow hot swapping (changing cards with the power on), but this capability may be missing and possibly unimportant for embedded applications.

Beware of bad designs

Apparently, at least a few PCMCIA drives don't incorporate all the good design practices that make for reliable operation. Solid evidence is hard to come by, but some manufacturers claim unnamed competitors either don't have the expertise to design reliable drives or are cutting corners and costs to sell in the price-sensitive retail PC market. Noise, ground bounce, and crosstalk are the reliability culprits, these manufacturers say. Reliability suffers primarily from poor circuit-board layout and from cables that are improperly terminated and inadequately driven.

Most of the available PCMCIA card drives are for use with desktop personal computers, thus the emphasis on reducing costs. These products are either internal units, which install in a drive bay, or external units, complete with housing and power supply. In either case, they connect to the PC with a cable. In most cases, the cable connects the drive to an adapter board that plugs into the PC's expansion bus. The drive may, however, connect to the PC's parallel port, serial port, SCSI port, or IDE interface.

You have fewer variables and fewer options when adding PCMCIA slots to embedded systems. Most PCMCIA card



Jerry,
I've found the missing link!
Greystone's new CardDock updates my PC to PCMCIA technology. It's exactly what we've been waiting for.
- Your Partner, Sue

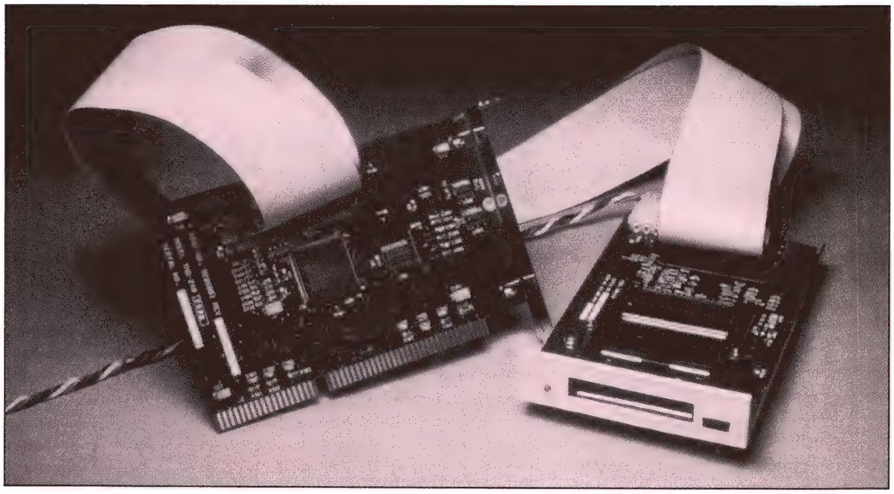
Add-in and add-on PCMCIA card drives, such as CardDock from Greystone Peripherals Inc, make it easy to add card slots to desktop computers.

PCMCIA CARD DRIVES

sockets for VME, STD, and PC/104 systems are on a plug-in board, so you don't have reliability concerns related to cabling. However, because most PCMCIA applications have centered around PCs, adaptations for other buses tend to be ad hoc creations that don't have the full range of capabilities outlined in the PCMCIA specification. Most embedded-system add-ins support only memory cards, a notable exception being Ziatech's ZT 8921, a board for the STD-32 bus with two card sockets for PCMCIA peripherals.

Of the many differences in PCMCIA card drives, quite a few merely reflect PCMCIA's relative newness. The PCMCIA standard is still evolving and hasn't yet been fully implemented. The standard also allows many different types and several different sizes of cards. (Indeed, much of PCMCIA's value stems from that diversity.) Consequently, PCMCIA cards and drives aren't, and won't be, quite the commodity items that floppy disks and floppy drives are. You have to make an informed selection based on your needs.

But you will also find that seemingly similar PCMCIA card drives actually have quite dissimilar designs. Some design variations stem from differences in the various socket-controller ICs (**Refs 1** and **2**) that are the heart of ISA-bus based card drives. Other variations relate more to noise issues, both in connecting cables and in a drive's controller board.



Most PCMCIA card drives for PCs, including Databook Inc's ThinCard Drive, connect a drive-bay assembly to an adapter board via a ribbon cable.

Noise is inherently a problem in PCMCIA designs. Socket-controller ICs, which establish an interface between a PC's ISA bus and a PCMCIA socket, generate quite a bit of noise by simultaneously switching numerous signals. If the design of a card drive's controller board doesn't take that noise into account with proper layout and good grounding, the drive may not operate reliably.

Cables only exacerbate the noise problem. Unlike notebook computers, which have PCMCIA card sockets on a circuit board, add-in and add-on PCMCIA card drives must use ribbon cables between an adapter board and a drive bay. These cables contain 80 to 100 pins per card socket, depending on how many ground and power connections they have, and can be up to 2 ft long. According to research performed by Vadem Corp (**Ref 3**), a manufacturer of socket-controller ICs, you must terminate these cables properly and drive them adequately for reliable operation.

Buffers on PCMCIA address, data, and control lines help deal with cable noise. Some PCMCIA socket-controller chips have built-in buffers; others rely on external devices—usually 244-type line drivers and 245-type bus transceivers. In either case, the buffers not only isolate PCMCIA card sockets from the computer's expansion bus (a requirement for hot swapping), but also serve as line drivers on the connecting cables. On-chip buffers can drive most cables, but external devices offer greater flexibility for special situations.

LOOKING AHEAD

More and more PCMCIA card slots will be appearing on desktop computers and workstations. Their presence not only aids in exchanging data with portable computers, but also allows sharing PCMCIA peripheral cards among different computers. In addition, PCMCIA cards use little power, an increasing requirement even for desktop systems.

The number of PCMCIA slots will also increase in embedded computers, although not at a breakneck pace. The abundance and potentially low cost of cards developed for portable computers are powerful incentives for migration to other applications.

PCMCIA cards are not always a good choice for the really harsh environments of industrial applications, however. Although a PCMCIA flash-memory card can be much more rugged than a mechanical disk drive, in general, the currently available PCMCIA cards can't tolerate extremely wide temperature ranges or severe shock and vibration.

PCMCIA cards show good potential in more hospitable embedded applications. Data acquisition is a promising application, as is computer security, in which a PCMCIA card serves as an access token.

As a technical specification, PCMCIA will continue to grow. It will more easily accommodate cards that operate at different voltages and will eventually include a 32-bit bus called CardBus. CardBus, to be patterned after the PCI-local bus (**Ref 4**), will be a full-featured bus with bus-master capability. Coincidentally, PCMCIA socket-controller ICs should soon be available for the PCI bus.

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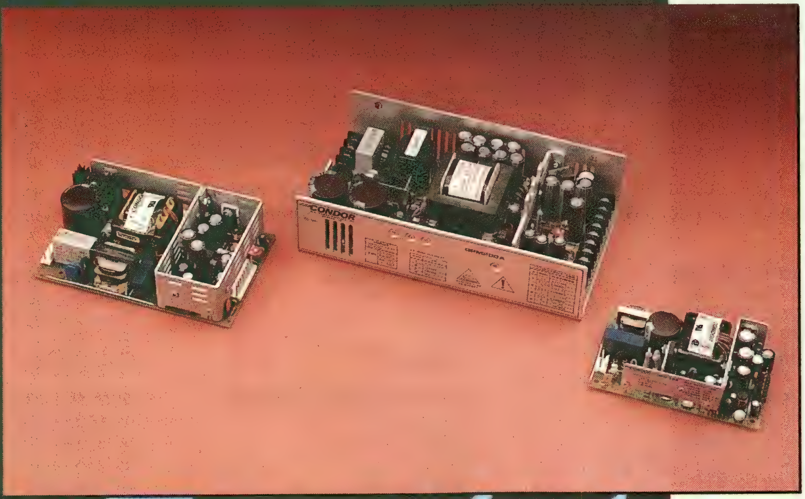

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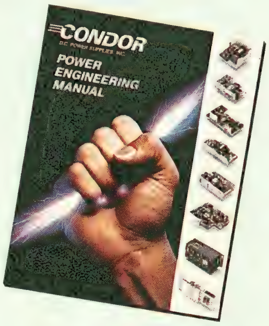

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But buffers aren't a panacea for cable noise. According to Kasturi Gopalaswamy, Cirrus Logic's marketing manager for PCMCIA ICs, a designer's expertise in dealing with a cable's transmission-line effects is equally or more important. A smart designer who matches impedances and looks after other variables, says Gopalaswamy, can guarantee successful operation over cables up to about 14 or 16 in. long.

In general, buffers are a requirement for longer cables. External buffers can deliver more driving current to cables, but other factors for improving signal transmission are also important. For example, says Gopalaswamy, Cirrus' socket-controller chips perform signal rounding to prevent cable ringing that would be induced by sharp transitions.

Some PCMCIA card drives apparently suffer from inadequate use of buffers. Some drive manufacturers omit buffers from the drive-bay assembly, at the cable end opposite the socket-controller IC. And you need buffers at both ends to run at full ISA-bus speeds, says PCMCIA design consultant Michael Mori. Otherwise, says Mori, author of a recent book on PCMCIA design (**Ref 1**), you have to put up with wait states.

In short, the issues of noise in general and cables and buffers in particular are complicated. There are no hard and

FOR FREE INFORMATION...

For free information on the PCMCIA products discussed in this article, circle the appropriate numbers on the postage-paid Information Retrieval Service card or use *EDN's* Express Request service. When you contact any of the following manufacturers directly, please let them know you read about their products in *EDN*.

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BG Technologies
Berkeley, CA
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Circle No. 303

Cardwell International Corp
Folsom, CA
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Circle No. 304

Chase Advanced Technologies
Bradford, UK
(44) 274-841316
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Circle No. 305

Coastal Electronics
La Jolla, CA
(800) 721-5465
(PC ISA bus)
Circle No. 306

Computer Dynamics
Greer, SC
(803) 877-8700
(PC ISA bus)
Circle No. 307

Curtis Inc
St Paul, MN
(612) 631-9512
(PC ISA bus)
Circle No. 308

CSM GmbH
Filderstadt-Plattenhardt, Germany
(49) 711-773-07173
(PC ISA bus, serial port, parallel port)
Circle No. 309

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Redmond, WA
(206) 881-6444
(PC ISA bus, parallel port)
Circle No. 310

Databook Inc
Ithaca, NY
(716) 889-4204
(PC ISA bus, parallel port)
Circle No. 311

Digital Equipment Corp
Maynard, MA
(508) 496-8891
(PC ISA bus)
Circle No. 312

Dovatronics
Longmont, CO
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Dynatem
Mission Viejo, CA
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Venissieux, France
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Mesa, AZ
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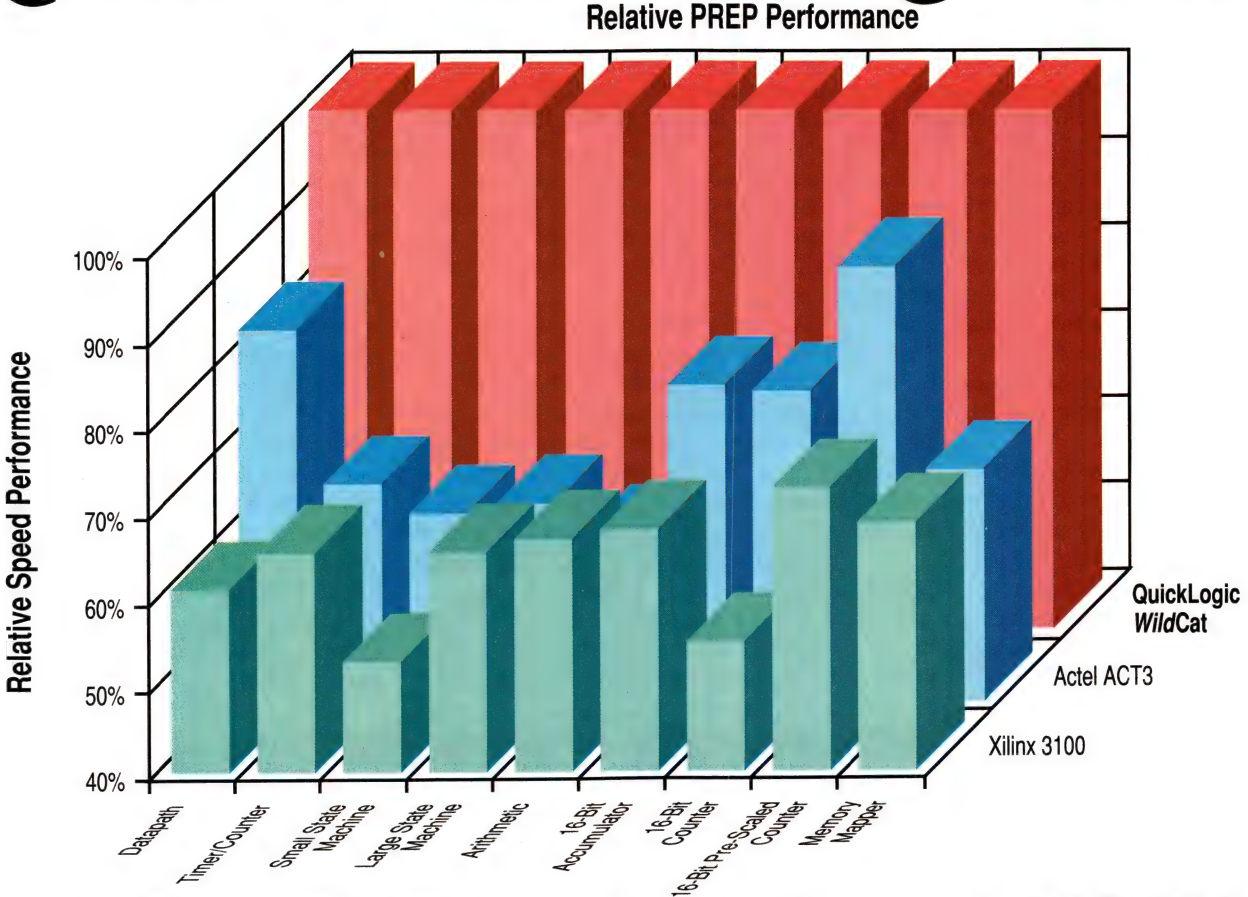

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fast rules for judging whether a particular card drive is adequately designed, but be aware that some may not be. If you're in the market for a PCMCIA drive, be prepared to ask some tough questions.

Consider, too, that the socket-controller IC's location determines the type and amount of cabling. In most add-in products, the socket-controller chip is on the adapter card that plugs into the PC's ISA bus. Cables connect the chip, either directly or through external buffers, to the card sockets in the drive bay. In a few products, however, the controller IC is on the drive-bay assembly. In these products, cables actually bring the ISA bus to the drive bay.

If a PCMCIA card drive has two or more card slots, having the controller IC on the drive-bay assembly reduces the amount of cabling needed. If space is tight, the difference could matter, and a single-cable approach should—theoretically, at least—reduce costs. In either case, reliable operation depends on a design that addresses noise issues.

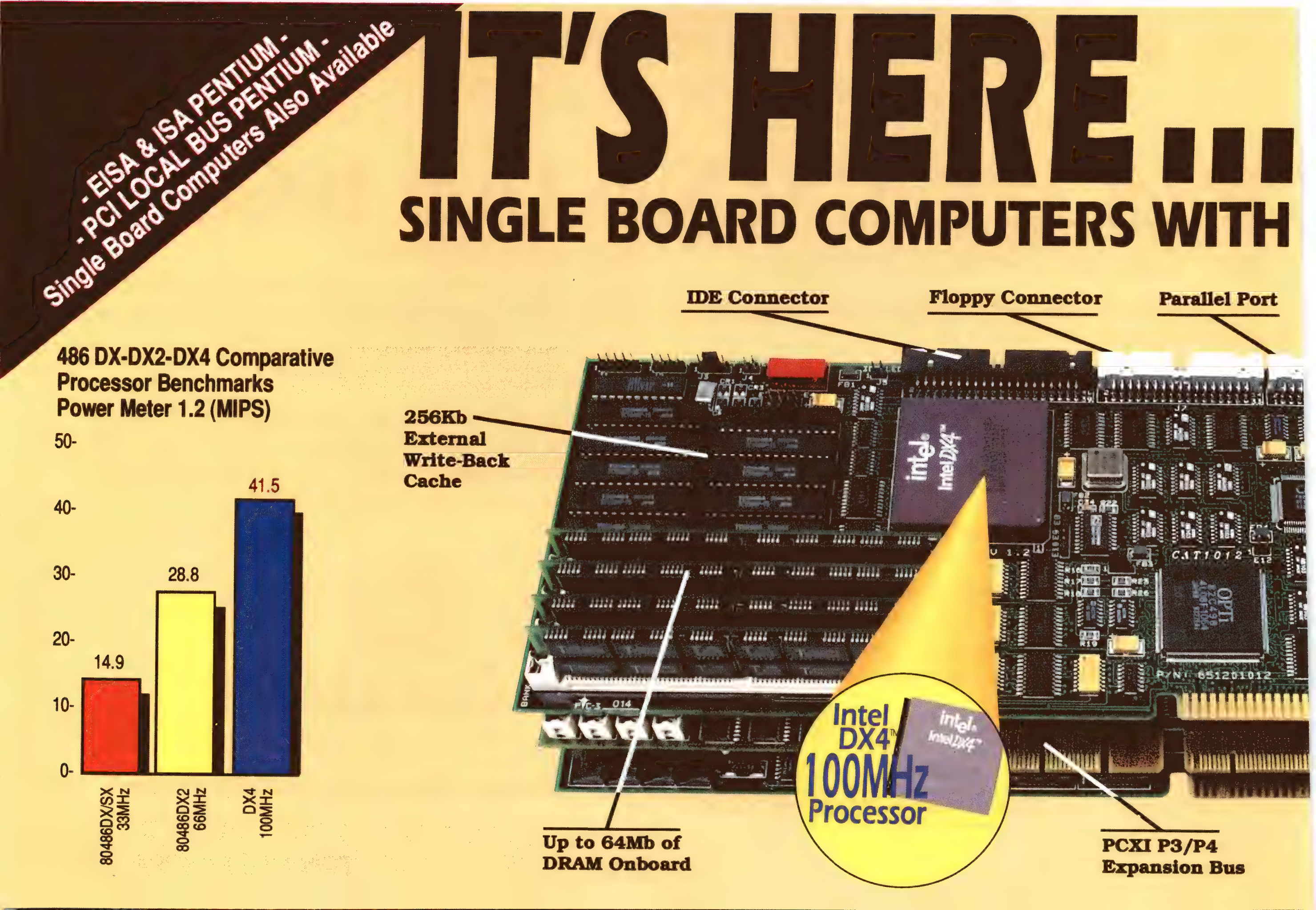
If you're concerned about the compatibility of a card drive with many new and future PCMCIA cards, make sure the drive supports both 5 and 3.3V cards. The first release of the PCMCIA specification supported only 5V cards, and some products still adhere to that release only. Also, be aware that some flash-memory cards require 12V for writing and programming. If you anticipate using these cards, be sure your drive provides 12V on the proper socket pin.

For compatibility well into the future, you may want to ask drive manufacturers about their plans for supporting a newer, more flexible voltage scheme that will be in the next revision of the PCMCIA specification. The new arrangement will include the use of voltage-sense connector pins and mechanical keys to identify cards' capabilities and to prevent damage.

Don't forget to consider power in your assessment of card drives, either. It's probably safe to assume that a drive can supply as much power as any PCMCIA card needs, except that—as we all know—it's never safe to assume. Bear in mind that a 1.8-in. disk drive in a PCMCIA card can draw 600 mA of current or even more during spin-up.

Finally, be sure you know what software you're getting with a card drive and, just as important, what software you need. For PCs, PCMCIA system software is very complex, providing all kinds of ease-of-use features related to hot swapping and automatic configuration. For embedded systems, those features are largely unnecessary—which is fortunate, since they're also unavailable.

PCMCIA system software for PCs consists of two main modules—Socket Services (a BIOS extension) and Card Services, which provides high-level functions to application programs. These modules are developed by only a handful of companies, mostly BIOS vendors who sell the software to hardware OEMs. Some hardware companies develop their own system software,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which may well suit your purposes. However, if you're concerned about broad compatibility, you'll want to be very thorough in determining just what the software will and will not do.

Is the software adequate?

A key question about software is whether it will work with all the different card types you anticipate needing. Memory cards, for example, will work with software that conforms only to PCMCIA Release 1.0; most peripheral cards, however, require Release 2.0 software. Flash-memory cards have their own software requirements. Unless a flash card emulates a disk drive, it will usually require flash-file-system software. This software, like Socket Services and Card Services, is provided to drive manufacturers by only a handful of companies.

Your choices in PCMCIA card drives are numerous. At least 30 companies make or sell drives, and many of these companies have numerous configurations that cover just about every combination of connectivity, card slots, and capabilities. For example, most card reader/writer units have one or two slots, but some have as many as eight.

Some add-in units for PCs put slots in a drive bay and additional slots on the rear of the computer. The front slots are for frequently used devices, such as memory cards, and the rear slots are for PCMCIA cards that are seldom removed and may require external connections, such as LAN-adapter cards. The rear PCMCIA sockets are on the adapter board that plugs into the ISA bus.

As a starting point for selecting a PCMCIA card drive, see **box**, "For free information…." The listings there indicate the types of systems that each manufacturer's drives connect to and the types of connection. However, because so many different card drives exist, with new ones appearing all the time, check with the manufacturers themselves for information on their latest offerings. EDN

References

1. Mori, Michael T, *The PCMCIA Developer's Guide*, Sycard Technology, Sunnyvale, CA, 1994.
2. Legg, Gary, "Special components simplify interface to PCMCIA cards," *EDN*, June 10, 1993, pg 61.
3. Fong, Henry, "Adding PCMCIA sockets to desktop computers," *EDN Products Edition*, November 15, 1993, pg 59.
4. Legg, Gary, "PCI local bus gathers momentum," *EDN*, February 3, 1994, pg 25.
5. Richter, Bryan, "Integrating PC card slots in desktop computers," *IC Card Systems and Design*, January 1994, pg 27.
6. "Buyer's guide: PC card reader/writers," *IC Card Systems and Design*, January 1994, pg 32.

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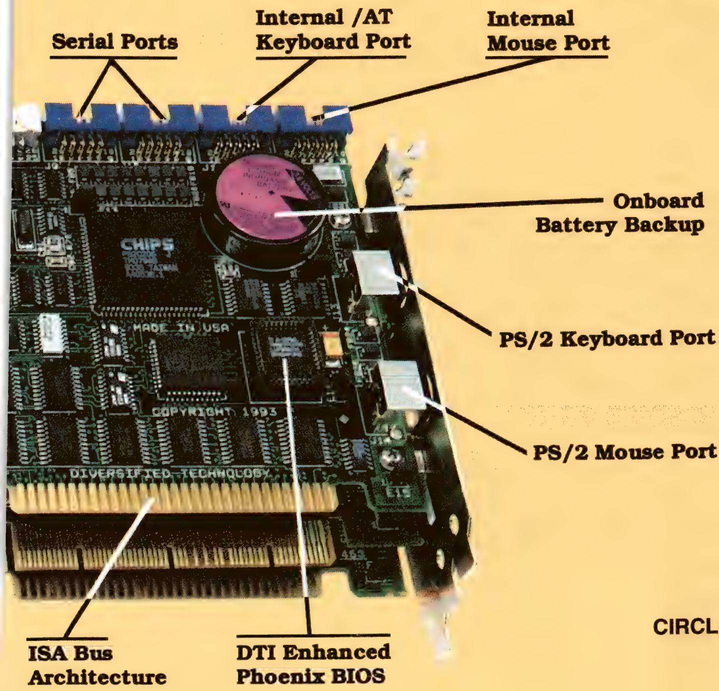

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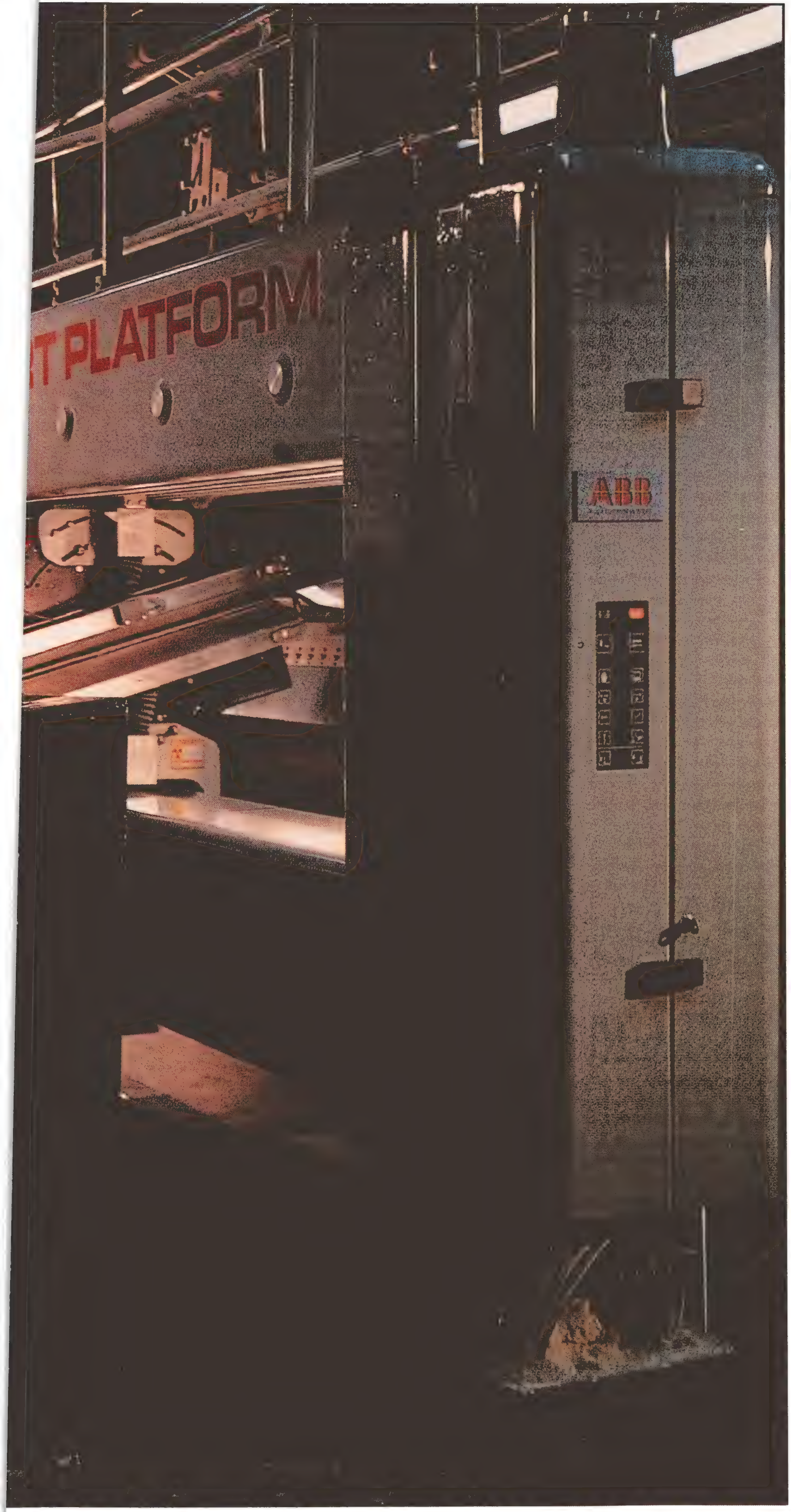

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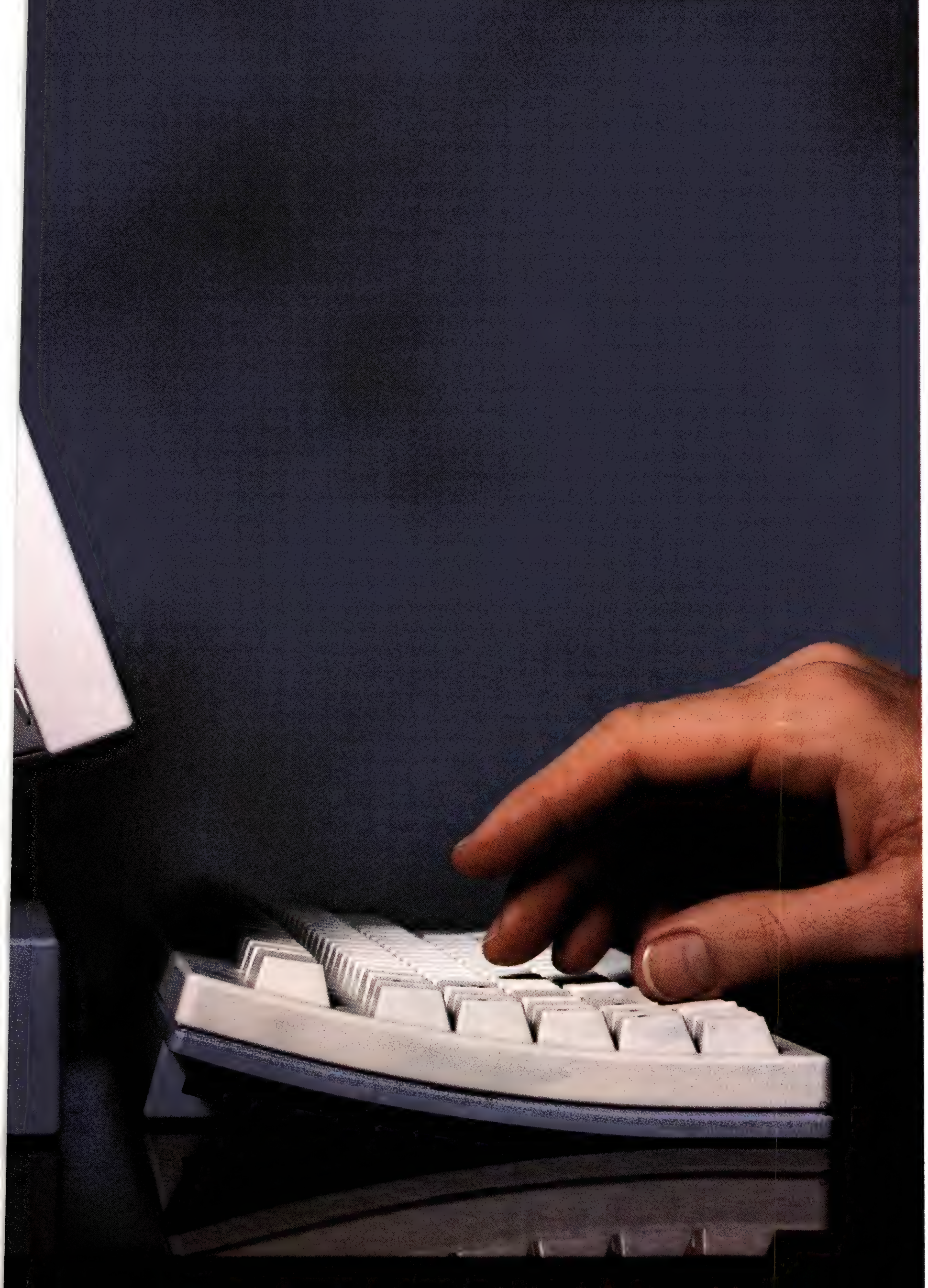

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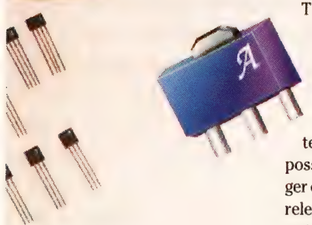

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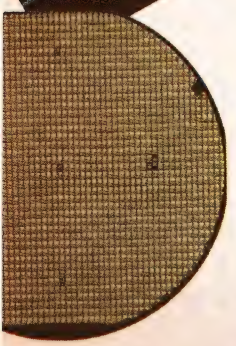

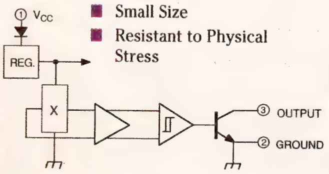

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- 4.5 V to 24 V Operation
- Reverse Battery Protection
- Superior Temperature Stability
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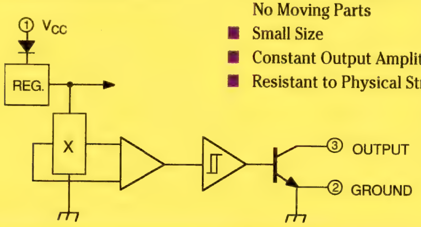
- Activate with Multi-Pole Ring Magnets
- Solid-State Reliability ... No Moving Parts
- Small Size
- Constant Output Amplitude
- Resistant to Physical Stress



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These Hall-Effect switches are monolithic integrated circuits with tighter magnetic specifications and switch points, designed to operate continuously over extended temperatures to +150°C, and are more stable with both temperature and supply voltage changes. The unipolar switching characteristic makes these devices ideal for use with a simple bar or rod magnet.

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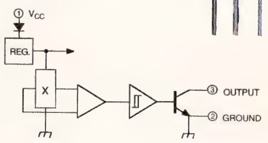
- 4.5 V to 24 V Operation ... needs only an unregulated supply
- Open-Collector 25 mA Output ... Compatible with Digital Logic
- Reverse Battery Protection
- Activate with Small, Commercially Available Permanent Magnets
- Solid-State Reliability ... no moving parts
- Small Size
- Resistant to Physical Stress



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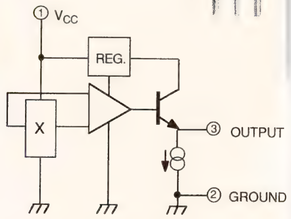

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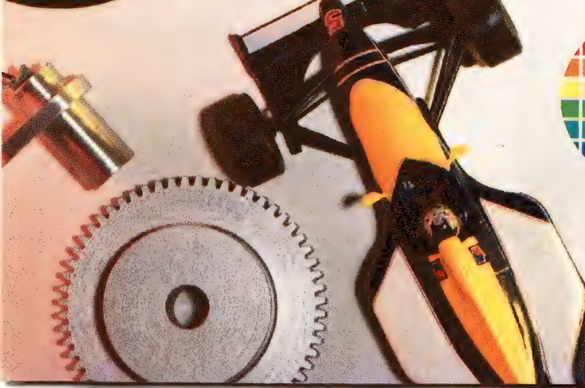

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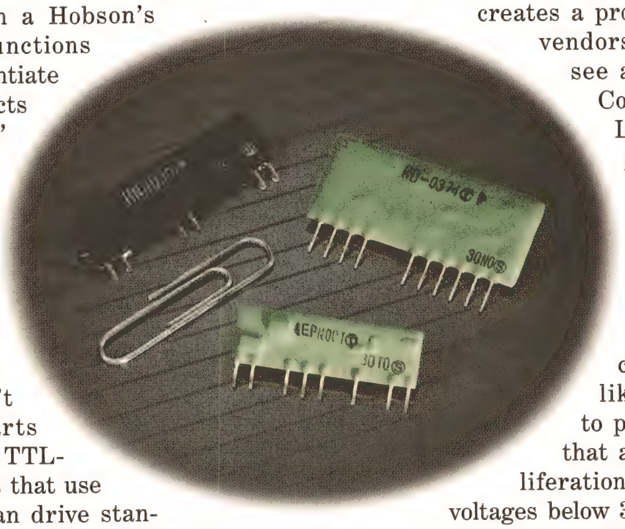
A surfeit of power-supply voltages plagues designs of compact products

DAN STRASSBERG, Senior Technical Editor

With logic-supply voltages multiplying like rabbits, designers of small products face some tough architectural decisions.

In the beginning, there was TTL. And TTL ran from 5V power supplies. Design engineers recognized the advantages of operating most of their circuits from a single standard supply voltage. And the industry adopted 5V. And it was good. Then it came to pass that the new semiconductor processes that produced parts such as the latest high-performance μPs yielded devices that wouldn't run at 5V. The new parts required lower voltages. The first of these was 3.3V…

If you're designing portable or battery-powered products, this situation confronts you with a Hobson's choice: Omit functions that can differentiate your new products from competitors' or add power-conversion devices in addition to the logic ICs that implement the new features. Certain functions just aren't available in parts that run at 5V. TTL-compatible parts that use 3.3V supplies can drive standard 5V logic, but can't run from 5V. Many 5V parts can't run (or don't run properly) from lower voltages.



About the smallest of power converters that aren't ICs are SIP units such as Xentek's HN, HW, EPN, and RD series (see above). These units, which convert 5V into higher voltages to drive LCDs, take up less than 0.5 in.^{2} on a pc board.

Just as engineers began to think they might devise ways to cope with these incompatibilities, rumors of parts with still lower supply requirements—3, 2.9, 2.7, 2.5, and even 2.2V—started to filter out of Silicon Valley. If designing with two logic-supply voltages is inconvenient, designing with three or more (or picking and choosing devices to keep the number of logic supplies down to two) can be really painful. Reliably and economically generating multiple supply voltages in a small space and with a minimum of wasted power is only part of designing for a mixed-voltage world. It is, however, the part we're addressing here. We'll leave for another day the subject of interfacing between logic ICs that operate from different voltages.

Problems become opportunities

When one group of IC companies creates a problem, other IC vendors are quick to see an opportunity. Companies such as Linear Technology, Maxim, and Micro Linear already offer ICs that generate both 5 and 3.3V (see **Table 1**). These companies are likely eventually to produce products that address the proliferation of logic-supply voltages below 3.3V. Right now, though, only a few ICs create supplies below 3.3V. Some resemble the parts that produce 3.3V. Many of those are in surface-mount packages—some thin enough to mount in 5-mm-thick Type I PCMCIA (Personal Com-

TABLE 1—REPRESENTATIVE POWER-CONVERSION PRODUCTS FOR LOW-POWER MIXED-LOGIC-VOLTAGE SYSTEMS

Vendor	Model	Price, quantity	Technology	Construction	Mounting	Input voltage (V)	Output voltage (V)
Astec Standard Power Circle No. 332	AA05A	$41.09, 100	PWM, 500V isolation	Module: 2×1×0.4 in.	Through-hole	9 to 36, 20 to 72, or 4.5 to 5.25	5
	AA03A	$38.55, 100	PWM, 500V isolation	Module: 2×1×0.4 in.	Through-hole		5
Calex Circle No. 333	5S5.1200LV	$55.13, 100	PWM	Module: 1×2×0.45 in.	Through-hole	3.5 to 16	5
Computer Products/Power Conversion America Circle No. 334	AFC5 Series	$48, 1	PWM	Module: 1×2×0.375-in.	Through-hole	4.65 to 5.25 or 10.8 to 13.2	5, 12, 15, ±12, or ±15
Conversion Devices Circle No. 335	300UR Series	$39.70, OEM	PWM	Hybrid; 24-pin DIP compatible	Through-hole	10 to 40 or 18 to 72	5, 12, 15, or ±5, 12, 15
Datel Inc Circle No. 336	UWR-3.3 Series	$36 (26W nonisolated) to $70 (20W isolated), 1000	Isolated: forward converter; nonisolated: buck	2×1×0.375- and 2×2×0.45-in. hybrids using SMT	Through-hole	9 to 18, 9 to 36, 18 to 72, and 4.6 to 13.5	3.3 ±1%; ±10% trim available on 20W nonisolated unit
Ericsson Components Circle No. 337	PKF 4000	<$20, OEM	Flyback	Thick-film hybrid	Through-hole, surface	38 to 72	2, 3.3, 5, or 12
		2V unit produces 3W; 12V unit produces 7W					
Harris Semiconductor Circle No. 338	ICL7660S	From $0.88, 1000	Switched capacitor	IC—8-pin DIP SOIC, TO-5	Through-hole, surface	1.5 to 12	–12 to +12
	CA733	From $0.34, 1000	Linear regulator	IC—14-pin DIP, TO-5	Through-hole	9.5 to 40	2 to 37
International Power Sources Circle No. 339	NME Series	$13.20, 1000	Buck/boost	Discrete	Through-hole, surface	3.3 ±10%	5 9, 12, or 15
		Available in SIP (0.24×0.5×0.4 in.), DIP (0.4×0.5×0.25 in.), and gull-wing SMT (0.3×0.5 in.)					
Interpoint Corp Circle No. 340	MSA 2805D	$630, 100	Flyback PWM	Hybrid	Through-hole	16 to 40	±5, ±12, or ±15
Linear Technology Corp Circle No. 341	LTC1143	$5.35, 1000	Dual step-down regulator	IC—28-pin SSOP	Surface	5 to 14	5 and 3.3
	LT1106	<$6, OEM	Boost regulator	IC—20-pin TSSOP	Surface	2 to 6	5 or 12 programmable
	LT1300	$2.53, 1000	Boost regulator	IC—20-pin DIP or SOIC	Through-hole, surface	>1.8	3.3 or 5
Maxim Integrated Products Circle No. 342	MAX786	$4.15, 1000	two PWM buck regulators	IC—28-pin SSOP	Surface	5.5 to 30	3.3 and 5 (PWM outputs to drive external MOSFETs)
	MAX783	$5.95, 1000	Two PWM buck regulators two flyback converters	IC—36-pin SOIC	Surface	5.5 to 30	3.3 and 5 (PWM outputs to drive external MOSFETs) plus two 60-mA PCMCIA outputs programmable to 0, 3.3, 5, or 12
	MAX767	$3.40, 1000	Buck regulator	IC—20-pin SSOP	Surface	4.5 to 5.5	3.3
Micro Linear Corp Circle No. 344	ML4873	$4.20, 1000	Two synchronous buck, two linear regulators	IC—28-pin SSOP and SOIC	Surface	5.4 to 30	From switching regulators: 5V and 3.3V; from linear: 12, 5V
		Instead of 3.3V, can produce voltages from V_{IN}–0.5 to 2.7V					

Output current or power	Efficiency (%)
5W	60 to 75 typ
3W	60 to 75 typ
1.2A	77 (5V input 1.2A load)
5W; (±12V 3.6W)	64 to 71 typ
3W	To 80
Isolated: 10W, 20W; nonisolated: 26W, 40W	Isolated: 75 typ; nonisolated: 90 typ at nominal input
3 to 7W	75 to 85 typ
To 40 mA	>95
To 150 mA	
0.8W	
1W	
5W	~70
Depends on external FETs; 2A/output typ	To >90
60 mA	To 85
To 500 mA	To 88
Depends on external components	~95
Depends on external components	~95
To 10A	>90
Depends on external components	>90 at 10V input, 10W output

puter Memory Card International Association) cards. A few of the 3.3V parts even provide outputs programmable to 12, 5, 3.3, or 0V at 60 mA, as the PCMCIA standard envisions.

System engineers can readily apply these parts; the data sheets—unlike those of many power ICs—don't need experienced power-supply engineers to interpret them. The ICs do, however, require external components. So turning them into working supplies requires some effort. Even though combining the ICs with capacitors, inductors, resistors, and FET switches is the most cost-effective approach for such high-volume products as cellular phones, notebook PCs, and personal digital assistants, it sometimes isn't the way to go. For products built in smaller quantities, in which holding down the development cost is more important than limiting product cost, modular or hybrid dc/dc converters can make sense. **Table 1** lists several such converters.

When you first think about generating multiple logic-supply voltages, several alternatives quickly come to mind (see **box**, "Some power architectures for mixed-logic-voltage systems"). In portable equipment, especially in battery-powered products, the use of a central multiple-output supply, such as an open-frame switcher, can be inappropriate. This scheme finds wide use in medium-sized products that aren't intended to be portable.

In products that use batteries, a common approach is to locate the batteries in the main product and charge them from an external ac-to-dc supply. Some products require you to remove the batteries for charging. In others, you can charge the batteries in place. In either case, a single-output ac/dc supply charges the batteries, and the unregulated battery output drives the power-conversion devices that produce regulated voltages to drive the logic ICs. If the product uses multiple supply voltages, this scheme is quite similar to the distributed-power architectures used in some larger products (**Ref 1**).

Portable electronic equipment most often uses NiCd, NiMH, alkaline, or sealed lead-acid batteries, all of which exhibit a large ratio of voltage at full charge to voltage just before they need recharging (or for nonrechargeable batteries, the voltage at the end of life). For most types, this ratio is at least 1.5-to-1. Therefore, a power-conversion device that produces a logic-supply voltage from a battery must operate from a wide range of input voltages. As **Ref 2** explains, the design of the conversion circuits is much more straightforward if the battery voltage is always higher (or always lower) than the regulated output voltage.

Although **Table 1** lists some devices that can manufacture 3.3 or 5V from voltages as low as 1.2V and so are suitable for use with a single cell (at least a single lead-acid cell; such cells produce approximately 1.65 to 2.35V), you probably want your battery to comprise several cells in series. Just before they need recharging, NiCd and NiMH cells each produce about 0.95V. Hence, six cells in series produce about 5.7V. Several of the ICs in **Table 1** operate with inputs as low as 5.5 or 5.4V.

At the other end of the scale, a fresh alkaline cell produces somewhat more than 1.5V. Six alkaline cells in series produce 10V or even a bit more. The ICs that produce 5 and 3.3V with inputs of 5.5 or 5.4V are quite comfortable with 10V inputs. In fact, some of them accept 30V. That's more than enough to work with the 15V you can get from a fully charged battery consisting of six lead-acid cells.

Several low-dropout linear regulators can produce 3.3 or 5V from an input that ranges from 5.4 to 10V. ($V_{DROPOUT}$ is the minimum input-to-output voltage for which a regulator produces a regulated output. If the voltage across the IC is less than $V_{DROPOUT}$, the IC does not regulate; changes in the input voltage appear substantially unattenuated at the output.) Nearly any linear regulator—low-dropout or not—can produce 5V from an input that varies between 10 and 15V, the range of voltages supplied by six lead-acid cells (automotive batteries contain six lead-acid cells).

Nevertheless, linear regulators are in most cases poorly suited to producing logic-supply voltages directly from battery voltages. The reason is low efficiency—at least when a fresh battery produces a voltage at the higher end of

TABLE 1—REPRESENTATIVE POWER-CONVERSION PRODUCTS FOR LOW-POWER MIXED-LOGIC-VOLTAGE SYSTEMS

Vendor	Model	Price, quantity	Technology	Construction	Mounting	Input voltage (V)	Output voltage (V)
Power Trends Inc Circle No. 349	PT6300	$19.90, 100	Nonisolated buck converter	0.6-in.-high SIP 0.36×2	Through-hole	4.5 to 10	3.3; can provide others trimmed to 1%
	78ST1	$10.40, 1000	Nonisolated buck converter	0.88×0.93×0.3 in.	Through-hole surface	6.3 to 20	3.3; others available
Semiconductor Circuits Inc Circle No. 350	A Series	$60 to $90, 100	PWM, 500V isolation	Modules: 1× 2×0.375 and 2×2×0.375 in.	Through-hole	36 to 60	2.2, 5, 5.2
		1-in.-wide, 2.2V unit provides 2.2W; 2-in.-wide, 5V unit produces 15W					
Semtech Corp Circle No. 351	MP7008	$18.80, 100	Nonisolated dc/dc converter	1×1.5×0.5-in. module	Through-hole	7 to 35	3.3
	MP7009		Nonisolated dc/dc converter; adjustable	1×1.5×0.5-in. module	Through-hole	7 to 35; must exceed V_{OUT} by >2V	1.3 to 30
	EZ Dropper	$1.86 to $3.50, 100	Linear	TO-92, TO-220, SOT-223	Through-hole, surface	5	3, 3.3, or adjustable
		2-terminal synthesized "low-voltage zeners"					
TelCom Semiconductor Circle No. 352	TC7660S TC1044S	$1.06, 1000	Switched-capacitor	IC (CMOS)	Through-hole, surface	1.5 to 12	V_{IN}×0.5, +0.5, +2, or −1
	TC55RP	$0.65 (TO-92); $0.70 (SOT-23/-89), 1000	Low-dropout linear positive regulator	IC	Through-hole, surface	To 11	3, 4, and 5 standard; 1.1 to 9.9 available
Tri-Mag Inc Circle No. 354	TDB3 TBD4 949ZW	$11.50, 1000 $19.50, 1000 $29.70,1000	Flyback; 500V isolation	Module 0.4×1.25×0.8 and 2×2 in.	Through-hole	All types: 24, 48, 5, or 12	3.3 3.3 3.3
Xentek Inc Circle No. 356	HN Series	From $3.50, OEM	PWM flyback	35×9.5×7-mm SIP hybrid	Through-hole	4.5 to 5.5	−22, −23, or −24
		Intended for powering LCDs					

the regulator's input range. A linear regulator that runs from 15V and delivers 3.3V is 22% efficient. It turns 78% of the power delivered by the battery into heat. Although the regulator's efficiency increases to as much as 33% as the battery voltage declines, the dissipation may even necessitate expending additional energy on cooling.

For battery-powered applications, switch-mode regulators are the rule. For one thing, their efficiency is nearly always higher than that of linear regulators (full-load efficiencies usually top 70% and often go above 95%). Switch-mode regulators' efficiency is also, to a first order, independent of input voltage. However, switch-mode regulators

LOOKING AHEAD

There are strong indications that the industry is entering an era of power-supply anarchy. The results will be greater product complexity, higher costs, and lower reliability. The bright young perpetrators of this mess weren't around in the days before logic-supply voltages became standardized, so they don't realize that they are toying with an element that fueled the electronics industry's explosive growth—the interoperability of tens of thousands of digital-IC types. Proliferating supply voltages can kill (or at least cripple) the goose that laid the golden egg.

Maybe it is time to begin phasing out the 5V standard. But if the industry must have several logic-supply voltages, it ought to pick just one voltage below 5V and stick with it for the rest of the decade. Just what that voltage should be is unimportant to this argument; power-supply vendors don't find that building 2.2V supplies is much harder than building 3.3V units. The capabilities of the logic chips produced by the new submicron IC processes should determine the supply voltage.

What counts is that there should be only one additional voltage. If there were, it would coexist with 5V for quite a while. Then, 5V would gradually fade away. When the lower voltage had supplanted 5V in nearly all new designs, the time would be right for yet another—and still lower—standard voltage. Such gradual evolution would not be without some drawbacks. But the industry could live with them; they would be far less painful than the chaos for which we appear headed.

Output current or power	Efficiency (%)
3A; 5A surge	>80typ
5W	>80 typ
2.2 to 15W	80 typ
3.3W	80%
1A max	80
I_{OUT} =0.25A to 1A	
I_{OUT}=20 mA	98% typ at V_{CC}=5V, I_{OUT}=1 mA
150 mA at 3V to 250 mA at 5V	$V_{DROPOUT}$ 380 mV typ at 200 mA
1.2W 2W 3.3W	70 typ (all 3.3V-output models)
20 mA	70 to 80

are generally more expensive than linear regulators, and they produce EMI, which can be troublesome, especially in applications that involve low-level analog signals.

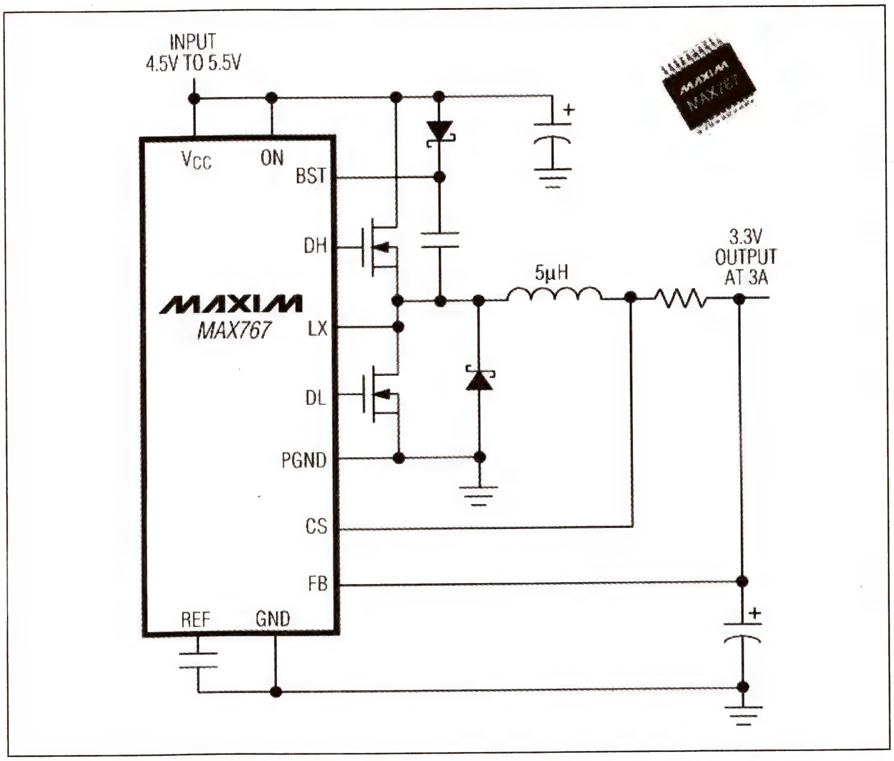
There are several circumstances in which linear regulators (or switching regulators with a narrow input range) are good choices in battery-powered products. Suppose you are redesigning a product, all of whose logic operates from 5V. In the successor product, most logic will still run from 5V; only one device (or a few devices) will run from a lower voltage. In such cases, you may well want to make the lower voltage from the 5V supply. A low-dropout linear regulator, such as the TC55RP from TelCom—which has a typical $V_{DROPOUT}$ of 380 mV at 200 mA—or the LT1121 from Linear Technology, easily deliver regulated 3.3V, even if the 5V supply is at 4.75V, the low end of its tolerance.

In this example, the linear regulator's efficiency is almost 70%. If the 5V supply actually produces 5.25V, the efficiency is still almost 63%. So here, you must ask whether a switch-mode regulator's higher efficiency justifies its added cost and complexity.

Another device worth considering in this example is Semtech's EZ Dropper. EZ Droppers aren't regulators; they're 2-terminal linear devices that simulate low-voltage zener diodes. You put them in series with the output of supplies whose output you want to drop, for example, a 5V supply that you want to reduce to 3.3V. (There is no such thing as a true 1.7V zener.) You might ask why you shouldn't do this job with a pair of forward-biased silicon diodes. The answer is that EZ Droppers offer a more closely controlled forward voltage and a lower series impedance.

As supply voltages decrease, a bit of extra design effort, cost, and complexity will be involved in building switch-mode supplies whose efficiencies match those of today's 5V-output units. Fortunately, the technology for producing even more efficient switch-mode regulators is in hand: Instead of using silicon-junction or Schottky diodes as rectifiers, power-supply designers will use synchronous rectifiers. The technology has existed for decades but has only recently been applied to power conversion. A synchronous rectifier (often, a bipolar transistor) has a forward voltage that is a small fraction of the 700 mV to 1.2V of a typical silicon-junction diode or the 400 to 700 mV of a typical Schottky rectifier.

Decreasing supply voltages increase the significance of supply output tolerances, which so far haven't been very important in low-power applications. Devices that operate from 5V are usually unfazed by supply voltages that differ from 5V by 0.25V. If the supply voltage is 2.5V, however, 0.25V represents a 10% tolerance. More than likely, the limits on 2.5V parts' supply voltage will be ±0.1V. The supply's open-circuit voltage tolerance is only a part of 5V ICs' allowable ±0.25V supply-voltage variation. Part of the allowable variation represents the IR drop produced by the flow of load current through the supply's output impedance; IR drops



Several vendors offer switching regulators in surface-mount packages. With a handful of external components, these ICs can provide 10W or more. Maxim's MAX767 produces 3A at 3.3V.

across pc traces also use up part of the 0.25V.

Although low-voltage versions of 5V parts consume less power than the original parts did, the low-voltage parts don't draw much less current. And there is a real possibility that future high-performance low-voltage parts will draw *more* current (though less power) than their 5V counterparts did. Given this scenario, the idea of tighter tolerances on the voltage applied to the ICs' supply terminals is a cause for concern. Having to hold the power-supply-output and pc-trace impedances to less than half of currently permissible values is not a pleasant prospect.

One vendor that boasts of its ability to produce parts with a tight output-voltage tolerance is Power Trends. The packaging technology of the company's original dc/dc converters won Power Trends *EDN*'s Innovation Award for power products a few years ago. Some of the parts are hardly bigger than a TO-220 transistor. Yet because of their high efficiency, they can deliver substantially more power than a linear regulator in a similar package. The automated manufacturing process that produces the parts permits laser trimming of output voltages to a 1% tolerance.

Isolated dc/dc converters can help to

SOME POWER ARCHITECTURES FOR MIXED-LOGIC-VOLTAGE SYSTEMS

1. Use a single multiple-output supply to produces all voltages.
2. Convert line-voltage ac to an intermediate dc voltage (perhaps the battery voltage); use switching regulators near the point of load to supply the several logic-supply voltages. (This scheme has many advantages.)
3. Use switching regulators to produce only the highest of the logic-supply voltages; create the others with linear regulators or narrow-input-range dc/dc converters. (This scheme is appealing if you are redesigning a product that used 5V exclusively and the new version still uses mostly 5V.)
4. Same as No. 3 but produce only the lowest of the logic-supply voltages with the main switching regulator; create the higher logic-supply voltages by stepping up the lower voltage with auxiliary switching regulators. (This technique makes sense in systems that have only a few ICs running from 5V, whereas most logic runs from a lower voltage.)

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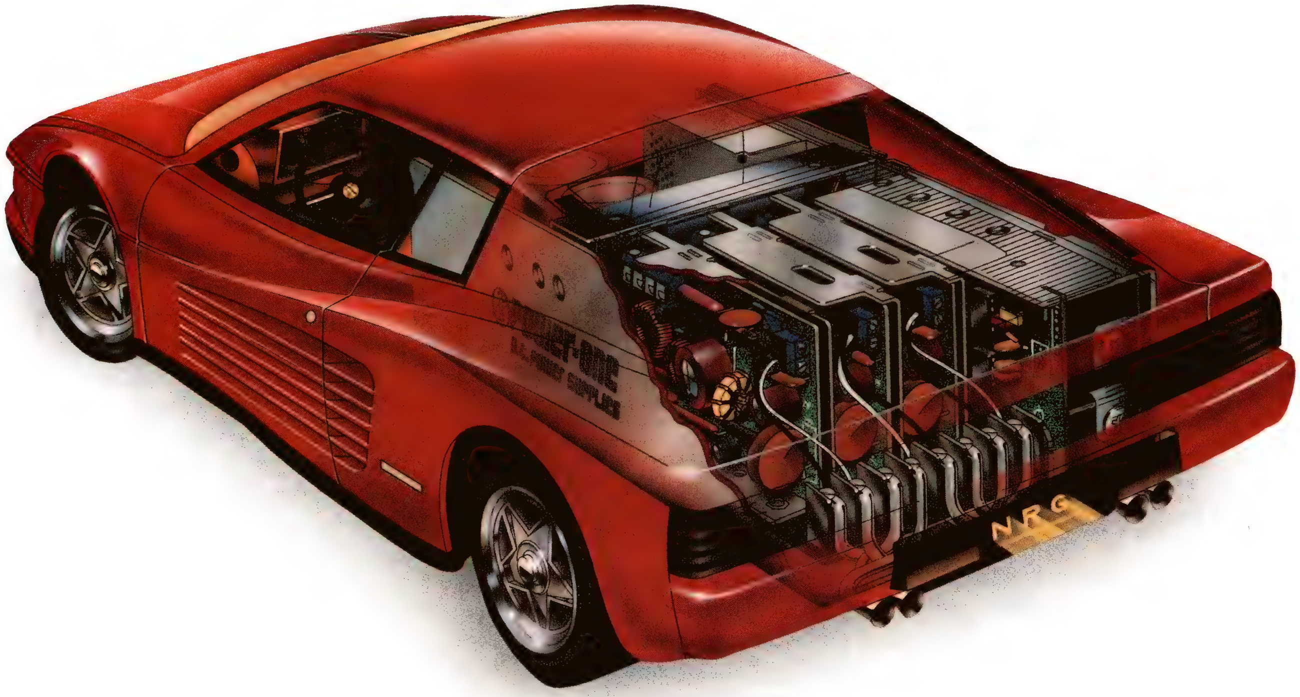

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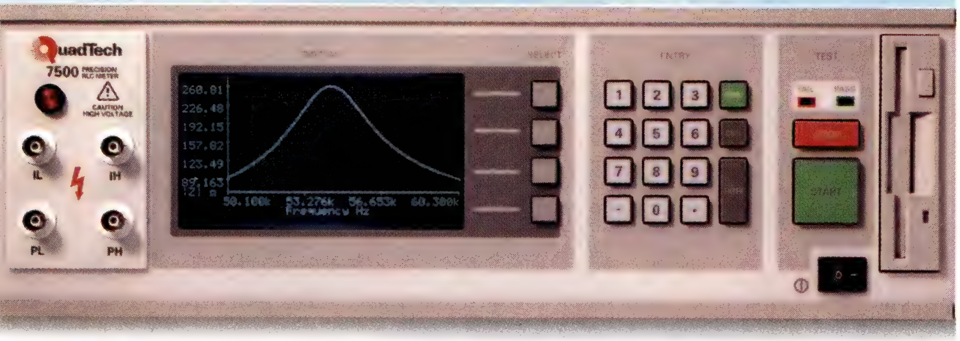

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POWER CONVERSION

mitigate the effects of IR drops in ground lines and ground planes. If you dedicate an isolated converter to powering one IC or a small cluster of ICs, you can limit the current that must flow long distances in ground lines. IR drops in ground lines then use up less of the ICs' supply-voltage tolerance. Nonisolated power-conversion devices can't accomplish the same thing. **Table 1** lists several small isolated converters.

Another potential problem is dynamic power-management schemes, which cause CPU clock rates to change rapidly. As the clock rates vary, so does the supply current. Without effective decoupling close to the devices whose supply current varies, rapidly changing supply currents cause nasty voltage spikes on supply lines and ground. These spikes may even be large enough to corrupt data.

Still another problem that may arise from using multiple logic-supply voltages is the need for sequencing of power-supply outputs. It is conceivable that ICs can suffer damage if a product's several power supplies power up in the wrong order. Some of the power-conversion products that **Table 1** lists have terminals that must be grounded (or ungrounded) before an output can appear. You can only hope that further investigation shows that if all of the logic voltages in a system come up at their own rates, no damage will result. Few users or designers of small systems would welcome the added complexity and unreliability that would result if supply sequencing were proven necessary. EDN

References

1. Small, Charles H, "Distributed power takes center stage," *EDN*, April 28, 1994, pg 54.

2. Moore, Bruce D, "Step-up/step-down converters power small portable systems," *EDN*, February 3, 1994, pg 79.

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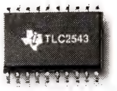
What's the brightest news in A/D price and performance in 1994?

TI's new TLC2543 12-bit A/D converter at $5.25*.



The TLC2543 from Texas Instruments sets a new price/performance point in the marketplace. Its power dissipation is only 5 mW typical. That's 50 percent lower than most 12-bit A/D converters, at about half the cost.

The right stuff. With the TLC2543 you get an on-board 14-channel multiplexer that offers 11 analog-input channels and three self-test channels. This 12-bit A/D converter has a 10-µs maximum conversion time and sample and hold. Plus a system clock and 8-bit control register. And an end of conversion flag makes it easy to interface with microprocessors and DSPs.

TLC2543 Features

- 12-bit resolution A/D converter
- 10-µs maximum conversion time
- Low power consumption — 5 mW (typ), 13 mW (max)
- Power-down mode — 125 µW
- Standard serial interface
- On-chip system clock
- 11 analog-input channels
- Available in 20-pin SOIC, DIP or PLCC packages

New Members of TI's A/D Family

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TLV1549	3.3 V	1 ch/serial	21 µs	10 bits
TLC1549	5.0 V	1 ch/serial	21 µs	10 bits
TLV1543	3.3 V	11 ch/serial	21 µs	10 bits
TLC1541/43	5.0 V	11 ch/serial	21 µs	10 bits
TLC1550	5.0 V	1 ch/parallel	6 µs	10 bits
TLC1225	5.0 V	1 ch/parallel	12 µs	12 + sign

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High-speed MODEMS

John Gallant, Technical Editor

High-speed modems help reduce telephone bills and speed remote access to data. Currently, you can choose between two nonsanctioned standards to achieve data rates faster than V.32bis. But expect a UTI-T-sanctioned, 28.8-kbps standard—albeit untested—this year.

It was just 1991 when the Consultive Committee for International Telephone and Telegraph (CCITT) ratified Recommendation V.32bis for full-duplex modem-to-modem communications—at the blazing speed of 14.4 kbps over the Public Switched Telephone Network (PSTN). Given the approximate 3-kHz bandwidth of the network, this seems an imposing task. But the public wasn't satisfied: Because of the cost of using PSTN, telecommunication companies, which transfer large data files, demanded even faster modem speeds to cut costs. Many of these companies were forced to use expensive proprietary equipment to obtain higher data rates, which also speed remote access to data.

Almost immediately, the CCITT—now named the ITU-T (International Telecommunications Union)—established the TR-30 Study Group (formerly SG XVII) to work on V.fast for modems that operate faster than 14.4 kbps. The V.fast draft recommendation, to be renamed V.34 after ratification, has been three years in the making. In order to satisfy the needs of members in the study group, V.34 has undergone considerable design and extensive changes since its inception in 1991.

The current V.34 draft, expected for final balloting in June, supports multiple data rates ranging from 2.4 to 28.8 kbps. Because of the extensible time lapse between V.32bis ratification and the proposed final ratification of V.34, a number of chip-set and modem vendors that were working on the committee set out to find alternative means for achieving higher bit rates. Participants divide into two camps: proponents of a public-domain standard called V.32terbo and supporters of a proprietary standard called V.FC (V.Fast Class), which Rockwell International developed.

Placed in public domain in 1993, V.32terbo delivers data rates of 16.8 and 19.2 kbps. The V.32terbo-standard proposal is a simple extension of V.32bis to bridge the transition to V.34. V.32terbo is a de facto standard; the ITU-T has not sanctioned it. Because it is a V.32bis extension, V.32terbo is fully compatible with the V.32 and V.32bis standards. The handshake is completely compatible, although V.32terbo did use the last two available bits in the V.32 start-up sequence. The symbol rate remains the same at 2400 baud, and two more points are added to the signal constellation.

Stars point the way

To distinguish one transmitted symbol from another, high-speed modems employ a constellation of symbol points (to represent specific amplitude and phase combinations) plotted on a 2D I-Q (in-phase-and-quadrature) graph. For example, a point in a hypothetical constellation might represent a symbol transmitted at 50% of maximum amplitude and 120° phase shift. The constellations contain the minimum number of points necessary to support a given data rate, which yields the maximum distance between symbol points.

The V.32bis-specification modification extends the 128-

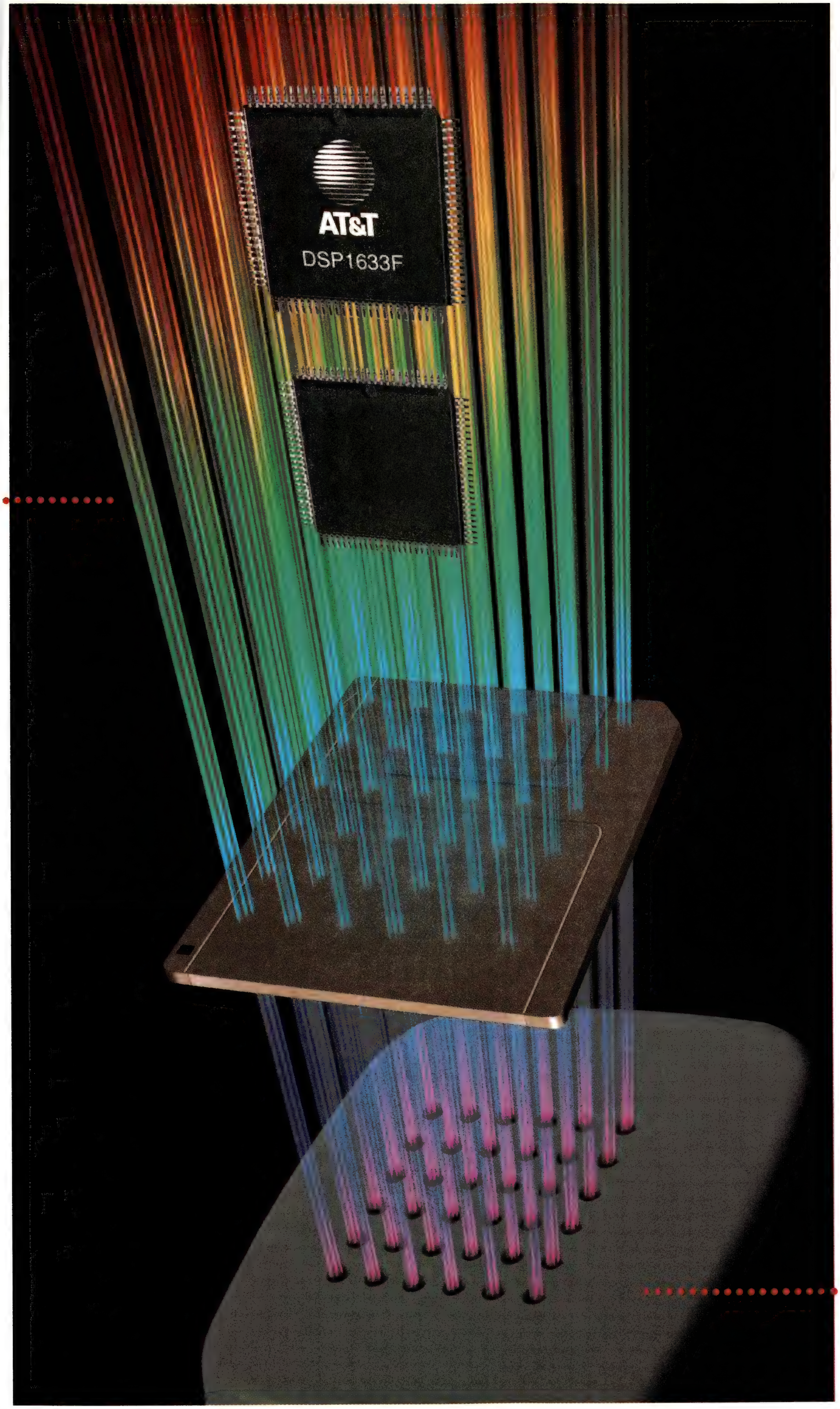

Photo courtesy
AT&T

point constellation for 14.4 kbps to 256 points for 16.8-kbps and 512 points for 19.2-kbps transmissions. To accomplish the higher point density, the V.32terbo standard introduced nonlinear encoding, which improves distortion immunity near the perimeter of the signal constellation. More than 40 modem vendors have modems that support the V.32terbo standard. Most of these modems cost the same as a V.32bis modem or slightly higher ($50 or less).

Currently, the two most visible chip-set vendors for the V.32terbo standard are AT&T and Phylon. Phylon has a chip set for V.32terbo designs employing data, fax, and voice transmission. The $69 (1000) PHY1013 and $72 (1000) PHY2011 consist of a DSP chip and a mixed analog and digital front end. An EPROM retains the DSP software; RAM holds the program during operation. The DSP architecture integrates MNP 2-5 and V.42bis error correction and data compression. V.42bis compression enables a V.32terbo modem to attain a throughput as high as 155,200 bps. Because the chip set is based on a software architecture called Tru-Speed, you can software-upgrade V.32bis products to V.32terbo or to V.34 when it becomes a standard. Depending on the implementation, you can upgrade the product over dial-up lines or floppy disk or by changing an EPROM.

Three angles of approach

AT&T has a 3-pronged approach for migrating to the higher modem speeds. AT&T offers three chip sets, called the DSP163x family, that integrate an analog codec onto the same silicon as a DSP1600 core. Each chip set comprises a DSP chip and a digital-interface device called VALV3x. All the devices share a common footprint. The DSP1632 ($55 (10,000)) supports V.32terbo, V.32bis, and V.17 standards and all fallback possibilities. The chip set doesn't require external RAM. The DSP1633F ($95 (10,000)) employs the company's V.flex technology, which lets you download upgradable DSP code into external RAM.

The V.flex modem comes with pre-V.34 release code that can be upgraded to the final V.34 standard when it becomes available. The ability to make software upgrades via floppy disk or dial-up lines eliminates the hassles of changing EPROMs, DSP chips, or daughtercards. The DSP1634 chip set will support the final V.34 standard as well as fallback specifications. The chip, which is ROM-based, can be used as a drop-in upgrade for the DSP1632 or for cost and power reduction when replacing a DSP1633F.

TXD RXD CTS DSR DTR CXR EC AA SYN SPD FAX
Z34-SX
FLASH V34/V.32terbo/V.32bis/V.42bis/Fax
DATA
TEST
ZYPCOM

The Z32t-SX modem from Zypcom operates at 19.2 kbps on dial-up or 2/4-wire leased lines using AT&T's V.32terbo chip set. The company will also sell a software upgrade to the 28.8-kbps V.34 Recommendation once the specification is ratified.

Rockwell International, a major modem chip-set vendor, chooses not to support V.32terbo. Instead, in late 1993, Rockwell introduced the V.FC proprietary standard. The V.FC family of single-chip devices offers speeds of 19.2, 24, and 28.8 kbps. The 19.2-kbps RC192AC/VFC costs $86; the 28.8-kbps RC288AC/VFC costs $123. Because V.FC now offers 28.8-kbps, full-duplex transmission speeds, more than 100 modem vendors already support the proprietary standard (according to Rockwell).

V.FC modems generally cost more than $500 each, but Microcom sells its V.FC Deskporte Fast and Travelporte Fast modems for $499. Microcom also recently introduced two low-cost versions of the Deskporte fast modem for $299 and $399. These modems don't have all the bells and whistles of their higher-priced counterpart. V.FC provides many of the advantages that the upcoming V.34 standard will provide. And similar to the other modem standards, V.FC has fallback modes that are compatible with standards ranging from V.32bis to Bell 212A and 103.

Although information on the operations of the proprietary V.FC chip is scarce, evidence exists that the chip is a subset of the proposed V.34 standard. The reason V.FC doesn't contain all of the V.34 features is that many V.34 features weren't finalized until January of this year. Some of these features include the handshake sequence and the trellis-encoding options. According to Product Line Manager Angelo Stephano, Rockwell has been participating in all of the V.34 meetings and working on a chip that will be fully V.34 compatible when the standard is ratified. The new chip will be pin-for-pin compatible with the V.FC chip. However, a V.FC modem user must replace a socketed 68-pin PLCC to upgrade to the V.34 standard. When the chip becomes available, Microcom will offer a $39 upgrade kit that will include firmware changes to flash memory.

All of which brings us to the draft V.34 recommendation. The working group wrapped up work on the specification in March and is expecting to send the draft out to members for final ballot in June. Assuming a normal time span for ratification, a final standard should be available approximately 60 days thereafter. Thus, V.34 chip sets (and even modems) may begin to propagate by the fourth quarter of this year. Sierra Semiconductor is one company that's working on a V.34 chip set to be ready by the fourth quarter.

Unfortunately, it may be a rocky road toward having a range of V.34 modems that routinely communicate at 28.8 kbps. The complexity of the V.34 speci-

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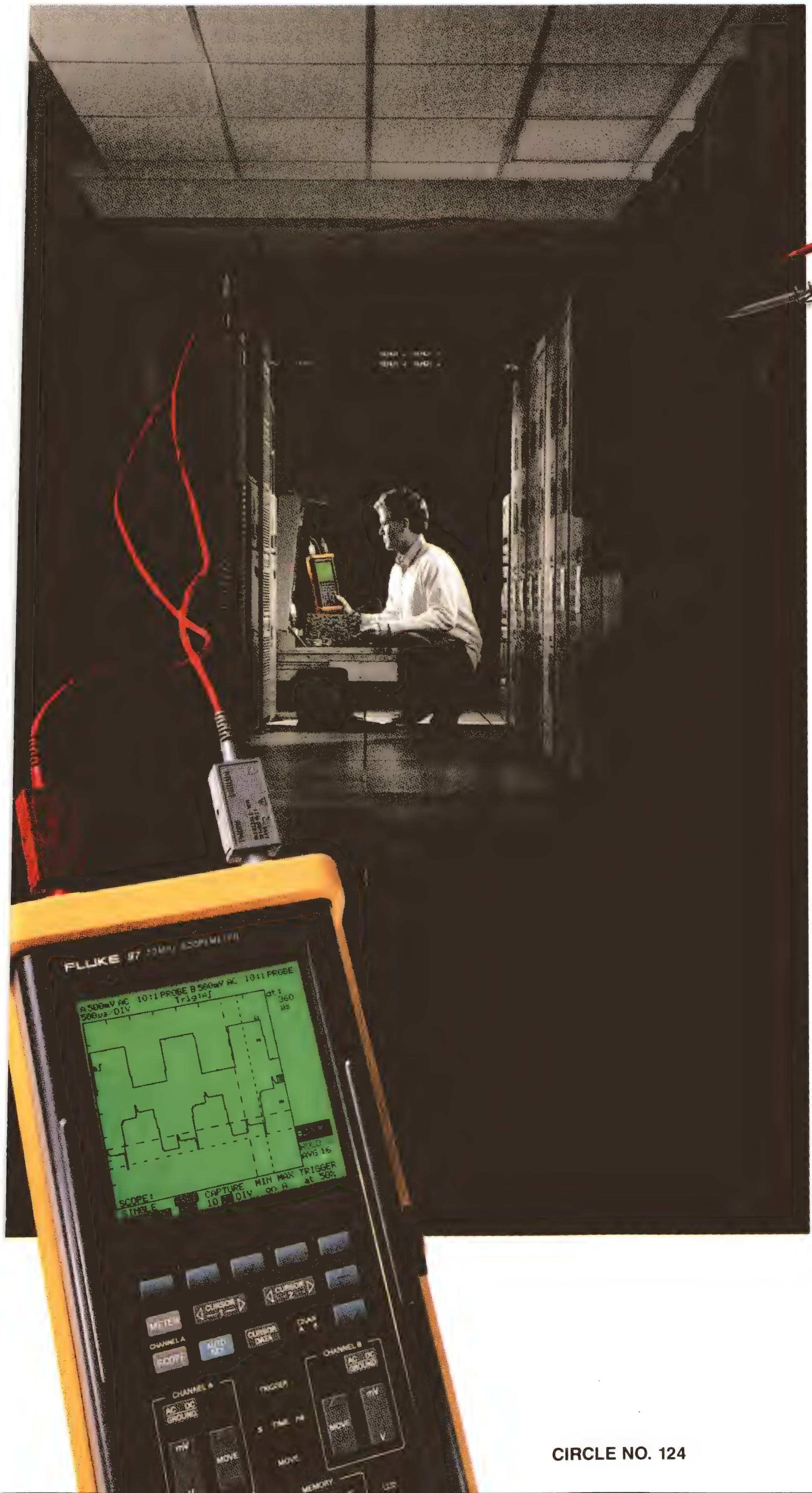

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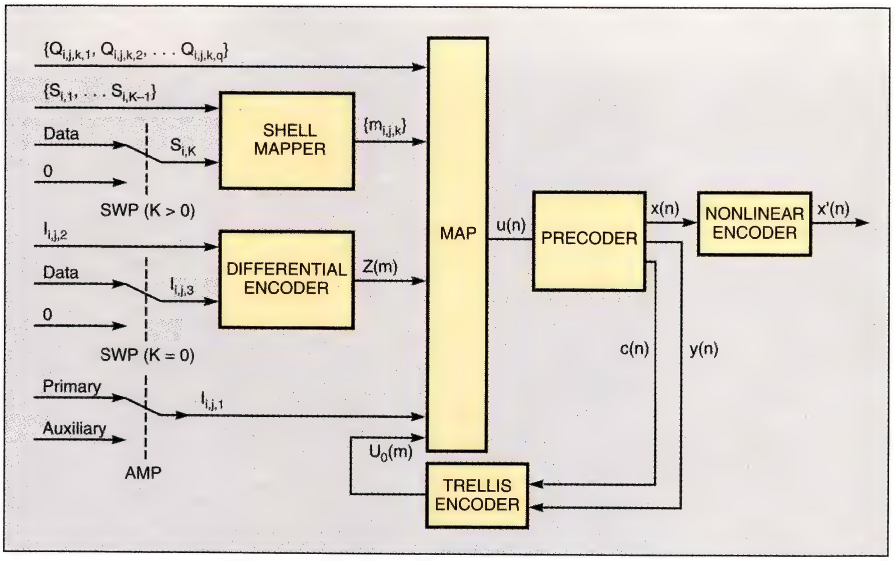

This schematic is an overview of a V.34-modem encoder. The draft V.34 Recommendation is extremely math intensive and provides the equations for generating the signals shown here. The schematic also shows a switch for multiplexing the 200-bps auxiliary channel with the primary channel.

fication is the reason. Perusing the V.34 draft recommendation seems a mathematician's joy—and an engineer's nightmare: The standard runs the gamut of complex mathematical operations. Essentially, the standard is a pool of many companies' desires; 10 companies reserve intellectual property rights to parts of the specification they plan to make available in a "fair and impartial" manner.

Unlike other modem specifications, the V.34 standard specifies synchronous line transmission at selectable symbol rates. The mandatory rates are 2400, 3000, and 3200 symbols/sec. Optional rates are 2743, 2800, and 3429 symbols/sec. In addition, one of two carrier frequencies can be selected at each symbol rate. The carrier frequencies range from 1600 to 1959 Hz. The choice of symbol rate and carrier frequency depends on line conditions that exist at connection time. The synchronous, primary-channel data-signaling rates range from 2.4 to 28.8 kbps in steps of 2.4 kbps. Transmission is either half- or full-duplex. An optional auxiliary channel having a synchronous data rate of 200 bps can also multiplex into the data stream.

The variety of symbol rates gives rise to the possibility of having a fractional number of bits/symbol. For example, transmitting 28.8 kbps at a symbol rate of 3000 symbols/sec yields 9.6 kbits/symbol. V.34 uses a sequence of embedded frames to transmit fractional bits/symbol. Symbols are spread over multiple frames. In this example, if 10 frames contain 96 bits, then each frame would have 9.6 bits/frame, where 10 frames constitute 10 symbols. As many as 15 frames can represent 15 symbols. These symbols embed within a superframe for trellis-code-modulator encoding, which reliably stores the multiple bits for each symbol (signal transition).

Trellis codes store information

A 4D trellis encoder generates the constellation points. Three optional convolutional encoders are available for three sets of trellis codes, each of which has a unique constellation pattern. The codes are called 4D 16-state Wei code, 4D 32-state code, and 4D 64-state code. The three trellis codes offer tradeoffs in decoder complexity vs immunity to Gaussian noise. For example, the 4D 16-state code should increase noise immunity over a V.32 2D 8-state code by approximately 1 dB, whereas the 4D 64-state code increases the immunity by 1.6 dB.

Therefore, a pair of modems using a 64-state code can operate 2400 bps faster than 16-state code. While two modems are negotiating a symbol rate, the modems probe the channel for Gaussian noise and determine whether the 16-state code is sufficient for optimal transmission or whether one of the more complex codes is required. All sig-

LOOKING AHEAD

It seems certain that we'll have a ITU-T-sanctioned 28.8-kbps modem standard, dubbed the V.34 Recommendation, by the fourth quarter of 1994. Look for compliant modems and chip sets at Fall Comdex. But the path to interoperability among modems from different vendors is neither clear nor direct. The draft standard describes only how the transmitter should operate—but neglects the receiver.

How individual vendors choose a combination of techniques for operation over a telephone channel will be proprietary to each manufacturer. It's possible that some manufacturer's V.34 implementations will work differently than other manufacturer's. Over a term of interoperability testing, the significant performance differences should disappear. Testing time could range from six months to one year. However, if you purchase a V.32terbo or V.FC modem now and upgrade to V.34, you can always use these de facto standards as fall-back modes until the dust settles.

The high-speed modem primarily suits the power user, not the casual user. Because AT&T charges by the minute to use the PSTN (not fractions of a minute), users have to transmit large files to save any amount of money. You can transmit a 200-kbyte block of data in one minute when operating at 28.8 kbps. Therefore, you need to transfer Mbyte-size files to reap any cost savings. A casual user generally transmits 10- or 20-kbyte files and, thus, won't see any difference in phone-line costs over using a V.32bis modem.

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CIRCLE NO. 108

nal constellation points are a subset of a superconstellation that has 960 points; the superconstellation forms by rotating 240 points distributed throughout a 2D constellation by 0, 90, 180, and 270°.

US Robotics has upgraded its line of Courier modems to V.terbo capabilities. The modems include the company's Adaptive Speed Leveling protocol, which boosts throughput to 21.6 kbps.

In addition, the draft V.34 recommendation employs a variety of equalization and power-control techniques not used in current modem recommendations. The new equalization techniques include adaptive preemphasis, precoding, shaping, and nonlinear coding (sometimes called warping). Preemphasis normalizes the transmit spectrum and is defined as the ratio of f/S, where f is the transmit frequency and S the symbol rate. The linear increasing transmit frequency compensates for PSTN bandwidth roll-off characteristics. Perfect compensation means that a signal applied to the digital network's backbone experiences a flat frequency response. Precoding is a nonlinear equalization method for reducing equalizer noise that causes amplitude distortion. The transmitter performs equalization using precoding coefficients the remote modem provides.

Trellis codes usually use equidistant points in the constellation. Some modem designers believe that you can improve noise immunity by concentrating the most frequently used points near the center of the constellation, which is called shaping. This technique can be of benefit when the connection is noisy. Shaping changes the distribution of points throughout the constellation. V.34 uses a shell mapper to shape the constellation points.

Nonlinear coding increases immunity to nonlinear distortion due to quantization noise. Think of this technique as another form of shaping, one that redistributes the points in the constellation (albeit in a different manner). Using nonlinear coding, the magnitudes of the low-amplitude signals reduce further, whereas the magnitudes of the high-amplitude signals increase. In this manner, it's easier for the receiving modem to distinguish between points closer to the center of the constellation and those in the outer regions.

In addition to the new equalization techniques, V.34 will be able to adjust the modem's transmit power to best match existing network conditions. High power can overload the receiver and introduce nonlinear distortion. A reduction in the power level eliminates this distortion and thereby improves the receiver's accuracy. US modem standards to date have specified –9 dBm as the maximum transmission power, which the FCC set. Other countries have established even lower power levels for maximum power. V.34 will use –9 dBm as a starting point for maximum power and allow the modems to negotiate power levels as low as –17 dBm in 1-dBm increments.

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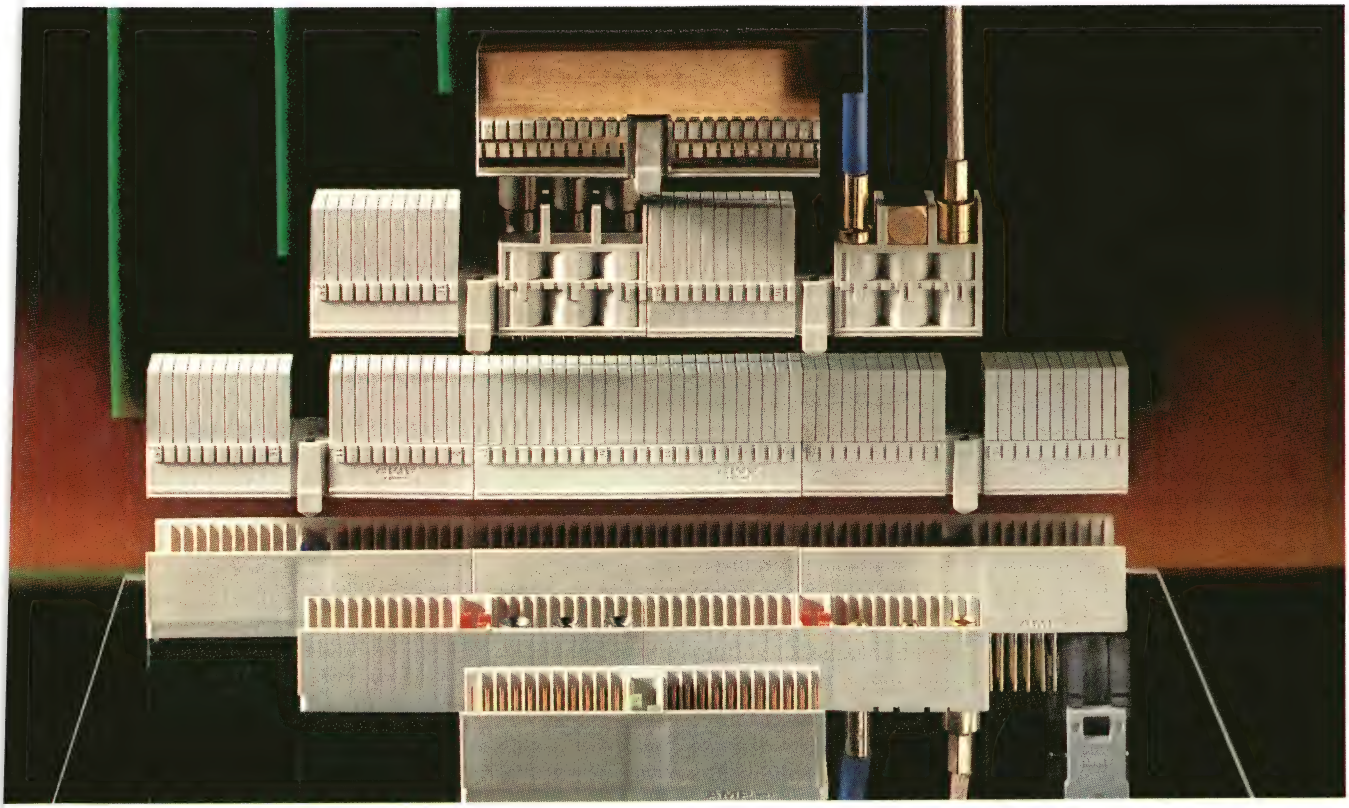

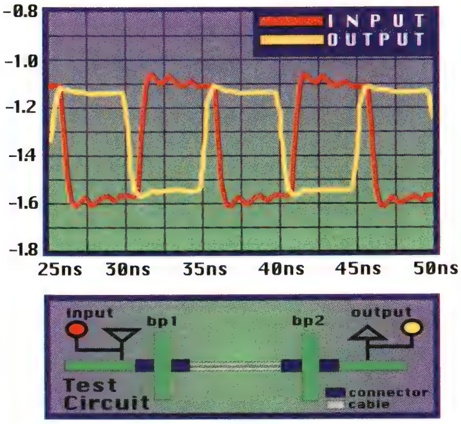

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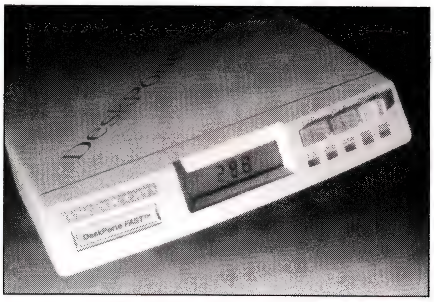

The Deskporte Fast modem from Microcom, a 28.8-kbps V.FC modem, achieves a throughput as high as 300 kbps using a parallel port and V.42bis or MNP 5 data compression.

The V.34 start-up sequence divides into four distinct phases. Phase 1 is a network-interaction phase, which identifies the transmitter as a V.34 modem and to establish the modem's capabilities. Phase 2 is a probing and ranging sequence that establishes maximum attainable signaling rate, carrier frequency, optimum power level, and preemphasis filter shape. Phase 3 sets the operating characteristics of the echo cancelers and equalizers. Phase 4 is a final training phase, which refines the operating characteristics of the echo cancelers and equalizers under full-duplex operation. The precoding coefficients are also set during Phase 4. The entire start-up task sequence takes 5 sec, which is impressive, considering a V.32bis modem needs 8 to 10 sec for start-up.

The high data rates proposed for V.34 will challenge more than just the telephone connection. The widely used RS-232C serial interface is specified to operate only as fast as 20 kbps. However, modem vendors claim they routinely transfer 115.2 kbps through the serial port using improved drivers and receivers and V.42bis data compression. Microcom adds a parallel printer port to provide a data throughput as high as 300 kbps using V.42bis or MNP 5 data compression. In order for V.34 modems to be reliable over the digital interface, new approaches to designing the interface are requisite. Clearly, a good deal of interoperability work will be necessary for V.34 modems to proliferate. EDN

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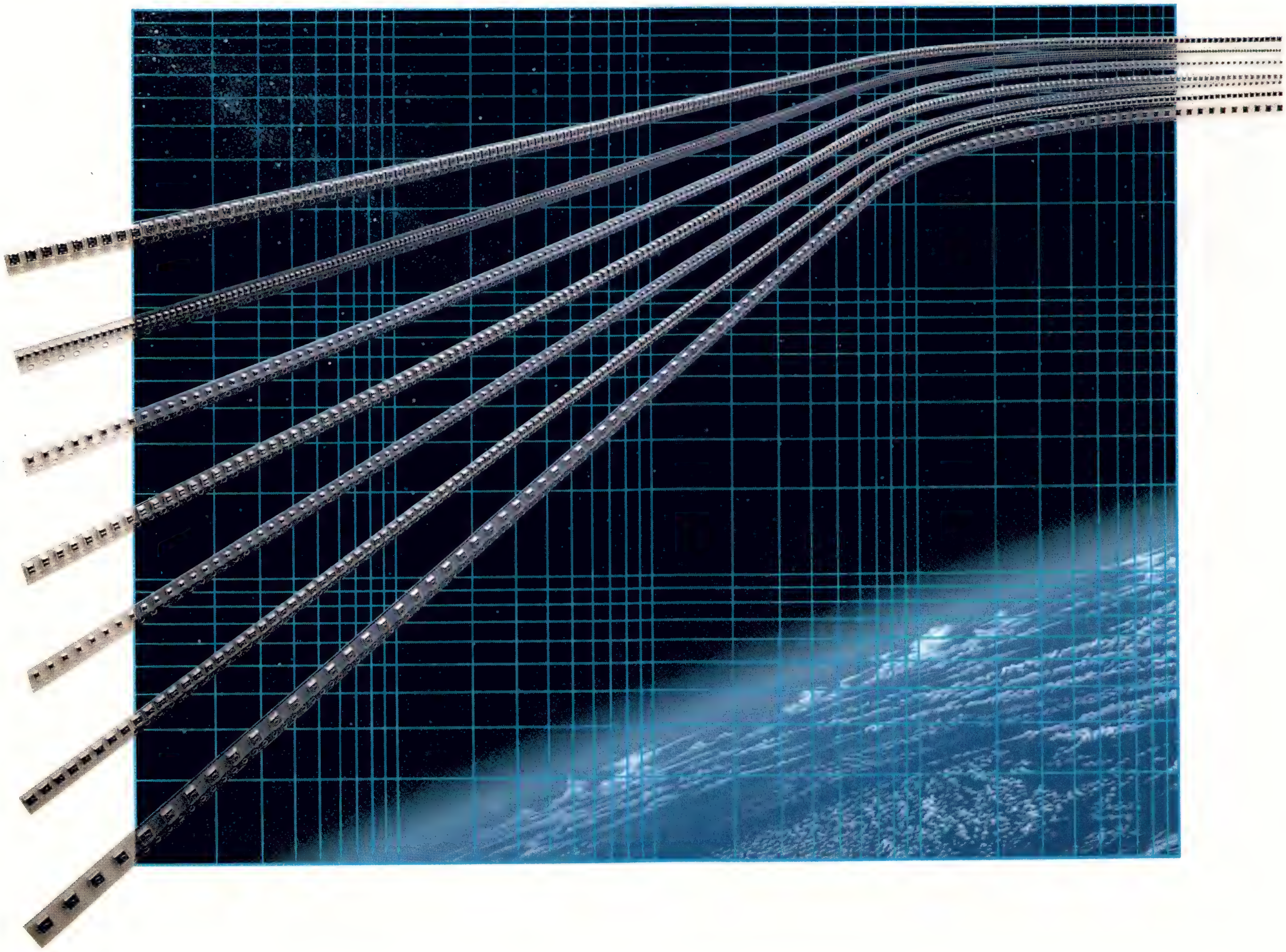

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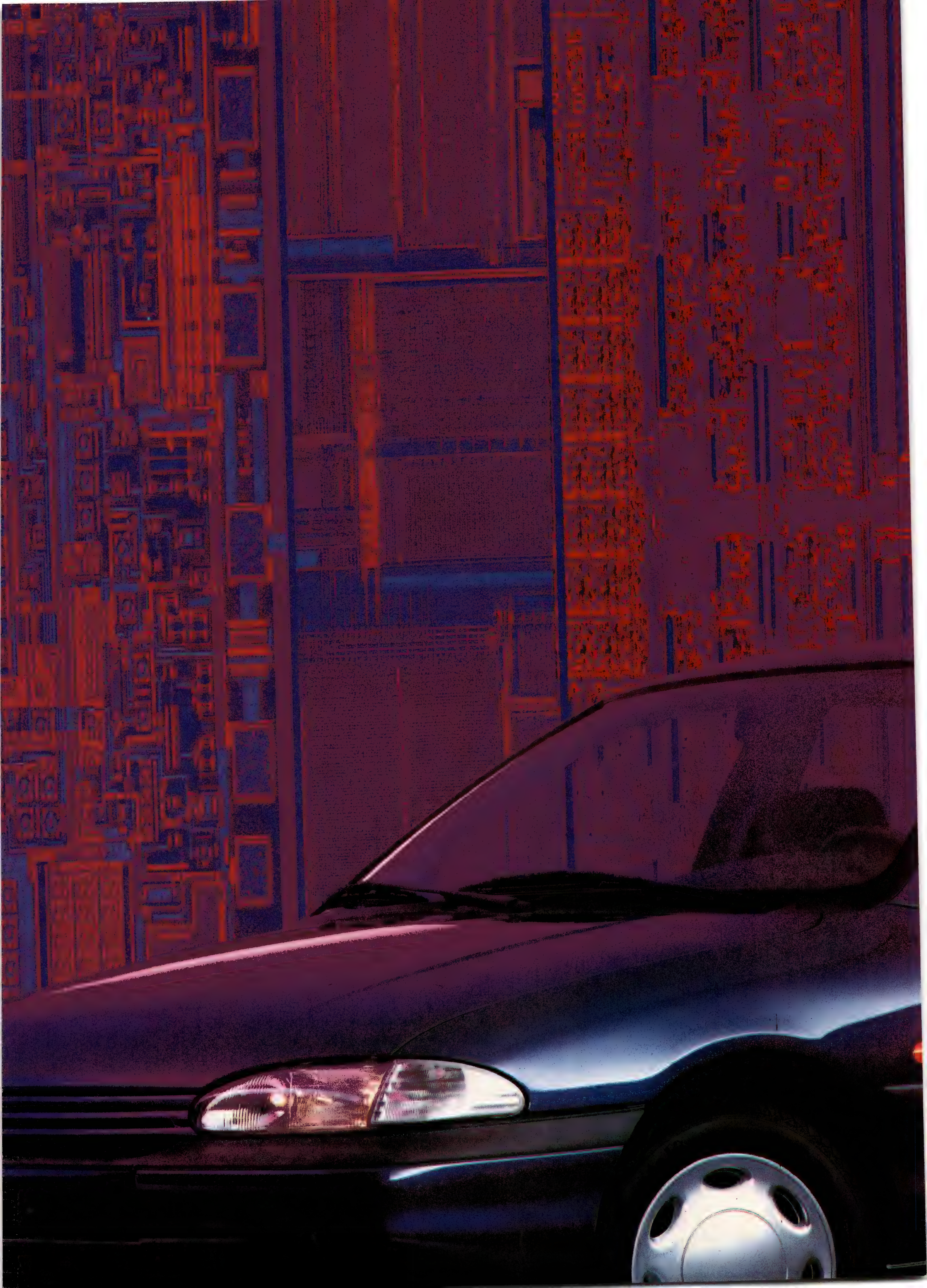

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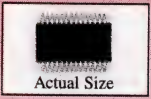

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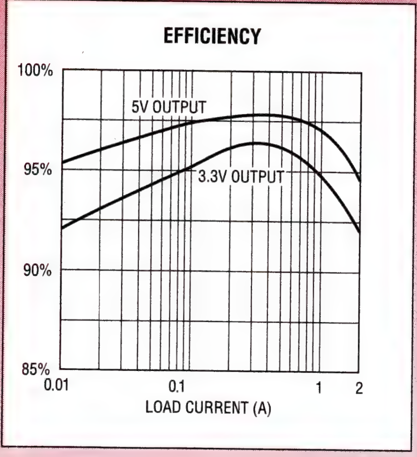

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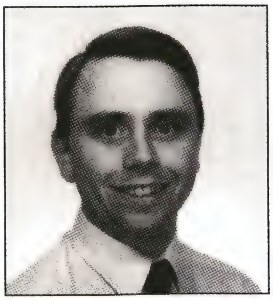
Solving a customer's problem leads to a winning idea

To say Ken Chapman is thrilled to be the 1993 Design Idea winner for his design "Fast integer multipliers fit in FPGAs" is an understatement. After the shock of learning he won, Chapman's reaction was one of wonder and pride that so many people had reacted favorably to his idea. "It's wonderful to come up with an application that people want to use," he says. The award is a nice bonus as far as Chapman is concerned, but the real excitement comes from learning that people around the world are using his design. "I've received two faxes from people in the United States saying they've used my design. It's a terrific feeling," he says. Chapman lives in England, where he works for Xilinx Ltd.



Chapman figured out how to manipulate multiplications to achieve multipliers with FPGA technology.

According to Design Ideas Editor Charles H Small, the $1500 award is well-deserved. He says the amazing thing about Chapman's design is that field-programmable gate arrays (FPGAs) are not usually associated with fast logic functions, such as multipliers. Yet, Chapman cleverly figured out how to manipulate the multiplications to achieve multipliers with FPGA technology.

Small adds that a tribute to the ingenuity of the design is the fact that it got such a high response, especially when most *EDN* readers don't use that type of technology. "This is a very specialized circuit that not every reader can use, but it got a very high vote," Small says.

Chapman's idea arose in the same way many innovations are born: He was trying to solve a customer's problem. The customer had asked Chapman if it was possible to run multipliers on an FPGA. Three months later, after the problem had "niggled around in [his] brain," Chapman figured out that is was possible, and came up with an idea of how to do it. Unfortunately for the customer, three months was too long to wait. But, Chapman didn't let the idea go. "I figured I should tell somebody about it, so I sent it off to *EDN*," he says. He has subsequently used the idea to help other Xilinx customers.

Chapman advocates that those who come up against interesting design problems work through them and submit a Design Idea. The payoff in helping fellow designers is worth the hard work.

Susan Rose, Contributing Editor

See pg 80 for Ken Chapman's winning design

Every month readers pick one Design Idea from the issue as the Winner of the Issue. The following are all of the 1993 winners. Congratulations to all the winners, and keep the innovative ideas coming.

January 7, 1993: "Four transistors measure rms power," Joseph L Sousa of Sipex (Billerica, MA).

January 21, 1993: "Simple algorithm finds inverse Z transforms," Donald Stefani (Leroy, NY).

February 4, 1993: "Simulation technique emulates oscilloscope," Alan Wolke of AMP Inc (Somerville, NJ).

February 18, 1993: "Backup shuts itself off," Yongping Xia of EBT Inc (Torrance, CA).

March 4, 1993: "PWM circuit operates below 1V," Dongtai Liu of Videx (Corvallis, OR).

March 18, 1993: "Optical transceiver uses a single LED," Enrique G Vicente de Vera, Jesus Mariño, Javier López (Madrid, Spain).

March 31, 1993: "Fast integer multipliers fit in FPGAs," Kenneth David Chapman of Xilinx Ltd (Byfleet, Surrey, UK).

April 15, 1993: "Algorithm exchanges elements," Kamran Husain of Mentor Programming Services Inc (Sugarland, TX).

April 29, 1993: "Solid-state fuse resets itself," Isaac Eng of ESTCO Battery (Ottawa, ON, Canada).

May 13, 1993: "Dual op amp takes absolute difference," Lindo St Angel of Motorola General Systems Sector (Arlington Heights, IL).

May 27, 1993: "PLD forms adjustable pulse-width generator," Aubrey Kagan of Weidmuller Canada Ltd (Markham, ON, Canada).

June 10, 1993: "Crystal clock produces precise period," Victor Koren of Orckit Communications Ltd (Ramat-Gan, Israel).

June 24, 1993: "VCO spans wide frequency range," Einar Abell of ADA Instruments (Three Rivers, CA).

July 8, 1993: "PC printer port programs PROMs," Yongping Xia of EBT Inc (Torrance, CA).

July 22, 1993: "Active filter makes component selection easier," Michael Wyatt of SSO Honeywell Inc (Clearwater, FL).

August 5, 1993: "Decoder demonstrates elegant DSP function," Leonard Schupak of Navitech Consulting (Irvine, CA).

August 19, 1993: "User sets digital potentiometer manually," Jacek Pawlowski of INMEL (Zielona Gora, Poland).

September 2, 1993: "3A charger has overcharge protection," Chester Simpson of National Semiconductor (Santa Clara, CA).

September 16, 1993: "Linear pots generate nonlinear functions," Alex Ureche of Alcon Surgical (Irvine, TX).

September 30, 1993: "Diode implements reverse battery protection," Mark Walsh of Rogue Engineering (Arvada, CO).

October 14, 1993: "Oscilloscope electrifies optical components," Alexander Belousov of Science Instruments (Baltimore, MD).

October 28, 1993: "3ϕ generator drives small motors," Stephen Theobald of Bang & Olufsen Technology (Denmark).

November 11, 1993: "Battery-powered adapter measures mΩ and μΩ," Larry Carr of Maxim Intergrated Products (Sunnyvale, CA).

November 25, 1993: "Charger provides 300 mA for NiCd batteries," Brian Huffman of Linear Technology Corp (Milpitas, CA).

December 9, 1993: "Power supply charges battery while carrying load," Dana Davis of Maxim Integrated Products (Sunnyvale, CA).

December 23, 1993: "Bicolor LED debugs FPGA systems," John Dean and Michael Epstein, Philips Laboratories (Briarcliff Manor, NY).

EDN's 1993 Grand Prize Winner!

Fast integer multipliers fit in FPGAs

Kenneth David Chapman, Xilinx Ltd, Byfleet, Surrey, UK

You can fit a fast and compact digital multiplier into a field-programmable gate array (FPGA). The technique involves using small look-up tables to find partial products and then adding the partial products. The key factor for making the design compact, fast, and easy to implement is to make the look-up tables for the partial products as small as possible. This multiplier can quickly multiply a number by a constant; changing the constant momentarily takes the multiplier off-line.

The 8x8-bit multiplier in **Fig 1** first develops all possible partial products for the constant operand, A_OPERAND, and loads those partial products into two 16x12-bit static RAM look-up tables. Preloading the look-up tables with only those partial products that can be obtained from the present value of A_OPERAND to the look-up table's address lines, greatly reduces the size of the look-up table. These partial products are:

0,1 x A_OPERAND,2 x A_OPERAND,...,
15 x A_OPERAND

These 16 partial products must be recalculated and reloaded for each new value of A_OPERAND. The accumulator, address counter, and small state machine (which accesses each location of the memory and stores a new partial product) together perform this modification. Clearly, the multiplier is unavailable from the time it receives a new value of A_OPERAND until look-up-table reloading is complete.

Next, the circuit splits the variable operand, X_OPERAND, into two 4-bit sections, using these sections as addresses into the look-up tables. These look-ups have the effect of multiplying each of the two sections of X_OPERAND by A_OPERAND and form two partial products. The circuit then combines the partial products by addition—and some judicious bit-weighting.

The adder requires 16-bit operands. The 12-bit partial products need to be converted to 16-bit values with the proper weighting. The circuit pads out the partial product from the low-order nibble out with four additional high-end zeros (weighting factor of 1). The partial product from the high-order nibble gets four additional low-end zeros (weighting factor of 16).

The *EDN* Readers' BBS contains a fuller writeup of this idea, including suggestions on expanding the design, as file DI1223Z.ZIP. **EDN BBS /DI_SIG #1223**

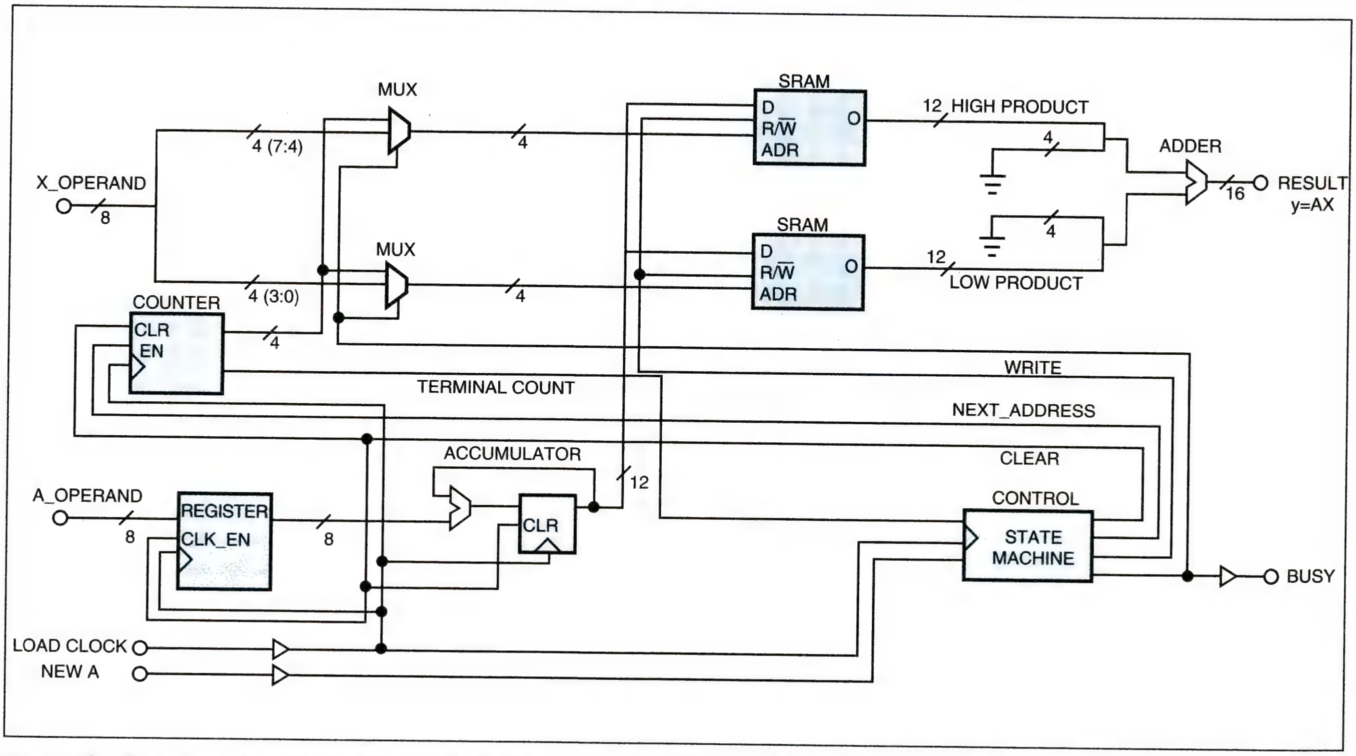


Fig 1—This 8-bit multiplier can multiply a variable by a constant quickly enough so that you can realize the design in an FPGA. The trade-off for achieving speed is that the multiplier goes off-line briefly every time you load a new constant.

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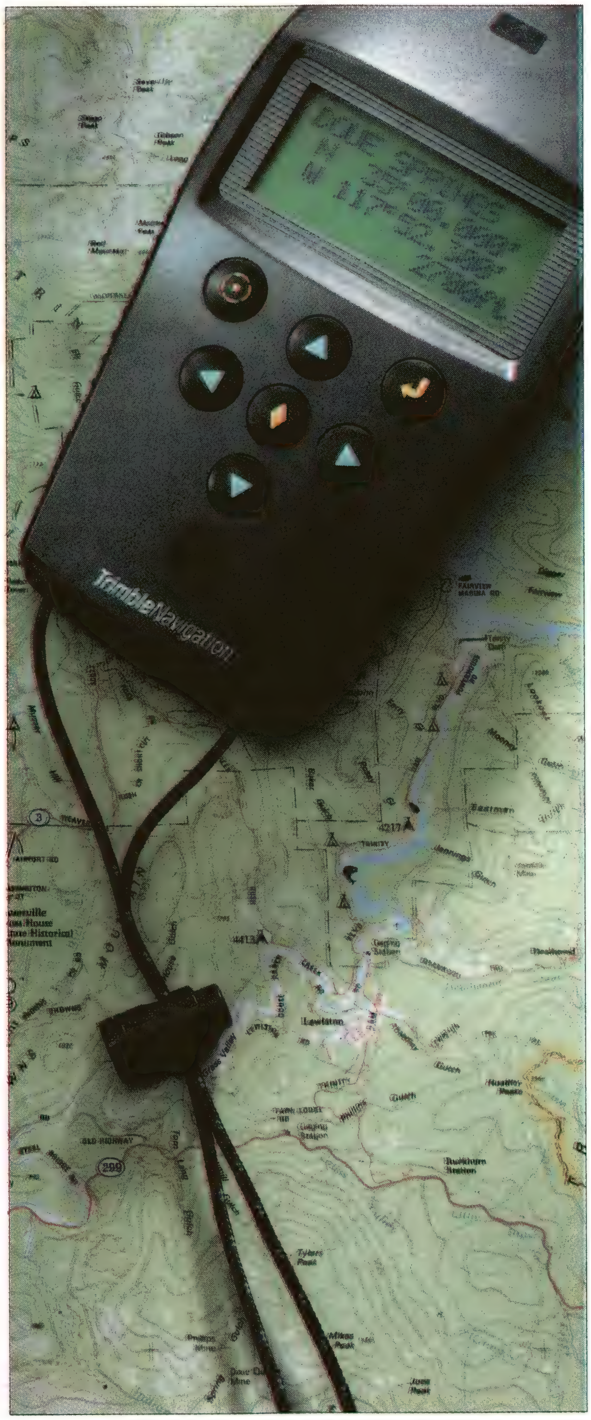

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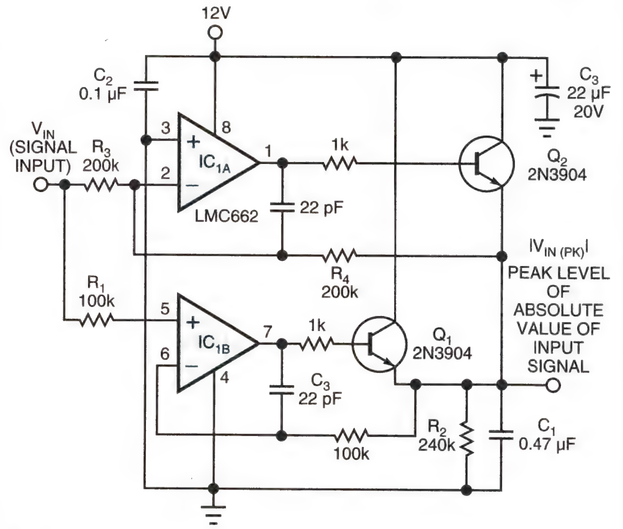
Dual-polarity peak detector operates from single supply

Chester Simpson, National Semiconductor, Santa Clara, CA

The circuit in **Fig 1** can detect the peak of either positive or negative inputs, yet it operates from a single supply. The circuit uses two unity-gain amplifiers to monitor the input signal, one an inverting amplifier and the other a noninverting amplifier. A typical application is driving a VU meter.



NOTES: 1. ALL RESISTORS ARE 1/4W, 5%.
2. CAPACITORS < 1 µF ARE CERAMIC.
3. CAPACITORS > 1 µF ARE ALUMINUM ELECTROLYTIC.

Fig 1—This circuit can detect the peak of positive or negative inputs, yet it operates from a single supply. The transistors boost the outputs of the op amps, ensuring a fast slew rate for the circuit's output.

The design takes advantage of a characteristic of the LMC662, IC_1. Although the op amp's data sheet warns against pulling inputs below ground, the op amp can withstand negative inputs if you limit the input current. In this circuit, R_1 limits input current to a very small amount. The op amp does nothing uncivilized, such as latching up or slamming against both rails, in this mode. It just waits patiently with its output at ground potential until the input signal goes positive and then starts following the input again. If you wish to substitute another op amp, check its performance first.

The outputs of the two amplifiers go through a "diode-OR" connection to C_1. Resistor R_2 bleeds off the voltage on C_1, determining the decay time of the output. The series path through R_1 and R_4 bleeds some current from C_1 but to negligible effect.

Q_1 and Q_2 ensure that current starving does not degrade the slew rate of the circuit. The transistors "turbocharge" the output of the op amps. Instead of the 20 to 30 mA available from the typical op amps, the 2N3904s can supply a peak current of 200 to 300 mA.

The 22-pF capacitors on the output of the op amps are necessary for stability because CMOS op amps do not like to drive capacitive loads. Locate capacitor C_2 near IC_1 because it bypasses the supply lead. C_3 provides the peak currents that Q_1 and Q_2 use to charge capacitor C_1. (DI #1415) EDN

To Vote For This Design, Circle No. 359

Verilog program models metastable flip-flop

Swapnajit Mittra, Wipro Infotech Ltd, Bangalore, Karnataka, India

The Verilog HDL program in **Listing 1** allows you to simulate the behavior of a set-reset (SR) flip-flop that has both its set and reset inputs high simultaneously. The outputs of a physical SR flip-flop become indeterminate in this condition. This property is the basis of circuits such as random-number and pseudo-noise-sequence (PSN) generators.

Simulating this simple circuit, however, poses problems. Software generates random numbers either by a predetermined sequence, such as linear congruential method, or by using a random parameter, such as the system time, as a seed. These methods require the software to map a range of numbers (probably floating point) to 1 or 0. These methods also need two software modules: one for the indeterminate case and another for normal behavior.

Verilog HDL provides system calls for generating random numbers whose statistical properties (distribution, mean, mode, etc) you can set very accurately. In particular, the system call *$random* generates a random number from the set

Listing 1—Behavioral model of set-reset flip-flop

```
module sr_flipflop(Q, QB, R, S, CP);
        input S, R, CP;
        output Q, QB;
        reg Q, QB;

        initial
        begin

                Q = $random;
                QB = $random;
                    // At $time = 0, Q and QB are both random
        end

        always @(posedge CP)
        begin
                if (S & R == 1'bl)
                        begin
                        Q =  $random ;
                        QB = $random ;
                    // Q and QB are random values
                        end
                 else
                        begin
                        fork
                        Q =  #1 S|(~R & Q);
                        QB = #1 ~(S)(~R & Q@-{1});
                        join
                        end
         edn
endmodule
```

Less buck for the bang

Motorola introduces new, lower Pressure Sensor pricing for the New Year!

We've made a New Year's Resolution for 1994 to get your sensor business, and to help kick it off we're offering many of our high-quality, high-performance Pressure Sensors at new, lower prices!

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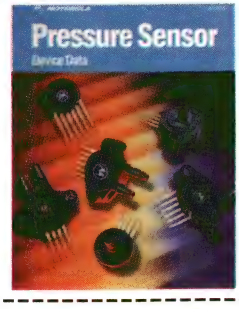

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{0,1}. Using this system call, the module *$sr_flipflop* in **Listing 1** models the circuit in **Fig 1**. When the simulation starts (*$time* = 0) or whenever the simulation sets SR = 1, *$random* develops the output Q and QB. Otherwise, the usual Boolean equations are in effect. (DI #1414)

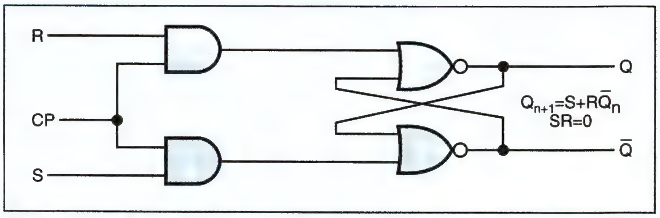

Fig 1—Simulating this simple set-reset latch poses problems if you attempt to model its behavior when both inputs go high.

To Vote For This Design, Circle No. 360

Laser printer prototypes pc-board artwork

Raj Shah and Dan Meeks, Q-bit Corp, Palm Bay, FL

A nifty method for generating artwork for prototype pc boards uses an ornamental foil originally made to simply dress-up printouts. To use LaserColor foil (Minds In Motion, PO Box 679, Lindhurst, NJ 07071), first draw the artwork, positive or negative, using any drawing program. Whatever is black on the printout becomes opaque on the finished artwork.

Next, using a laser printer, print your artwork onto a clear, transparent film. Next, cut a piece of the LaserColor foil and lay it over the artwork, tacking it in place with the little sticky dots supplied. Last, run the sheets through the laser printer again (form feed).

When the film passes over the drum inside the printer, the foil sinters onto those areas of the film that are covered with toner. When you peel over the extra foil, you have artwork suitable for photoetching a pc board.

At least one product similar to LaserFoil is on the market. But the advantage of LaserFoil is that you need to use a piece of foil only as large as the artwork; the other method requires feeding a whole sheet through at a time.

The foil's real purpose is being applied to paper to dress up reports. The foil behaves differently when you try to apply it to clear film. You have to experiment to get consistent results. The most important factor is the type of clear film on which you are printing. Don't use the standard overhead-transparency film because it causes the toner to become blotchy and thin. You need a dense coating if the foil is to adhere really well.

A sticky-backed film, such as Rayven 320 (Rayven Inc, 431 N Griggs St, St Paul, MN 55104), is a little cloudier than the overhead-projector film, but the toner takes to it very well. You have to apply the sticky-backed film to a sheet of clear film to keep it from sticking to the innards of your printer. Luckily, overhead-transparency film works great for *this* application.

Also, as with any other photographic artwork, you get better results if you print a mirror image so that the foil is against the pc board when the board is being developed. This orientation keeps the light from diffracting through the film around the foil and etching away more copper than you intend. (DI #1418)

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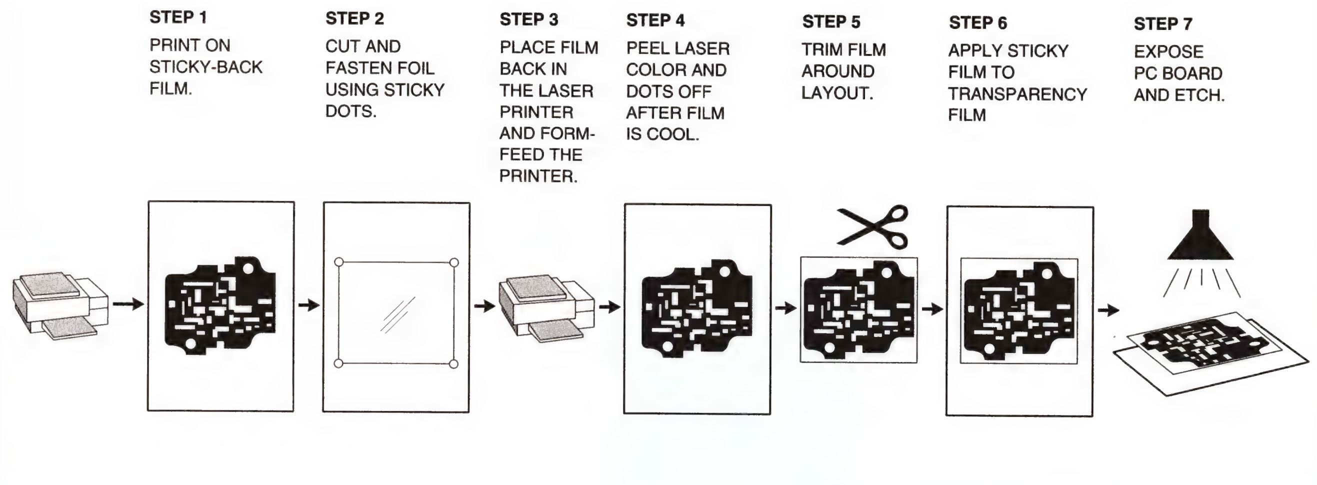
STEP 1
PRINT ON STICKY-BACK FILM.
STEP 2
CUT AND FASTEN FOIL USING STICKY DOTS.
STEP 3
PLACE FILM BACK IN THE LASER PRINTER AND FORM-FEED THE PRINTER.
STEP 4
PEEL LASER COLOR AND DOTS OFF AFTER FILM IS COOL.
STEP 5
TRIM FILM AROUND LAYOUT.
STEP 6
APPLY STICKY FILM TO TRANSPARENCY FILM
STEP 7
EXPOSE PC BOARD AND ETCH.

Fig 1—A few simple steps adapt an ornamental metal film to prototyping pc boards.

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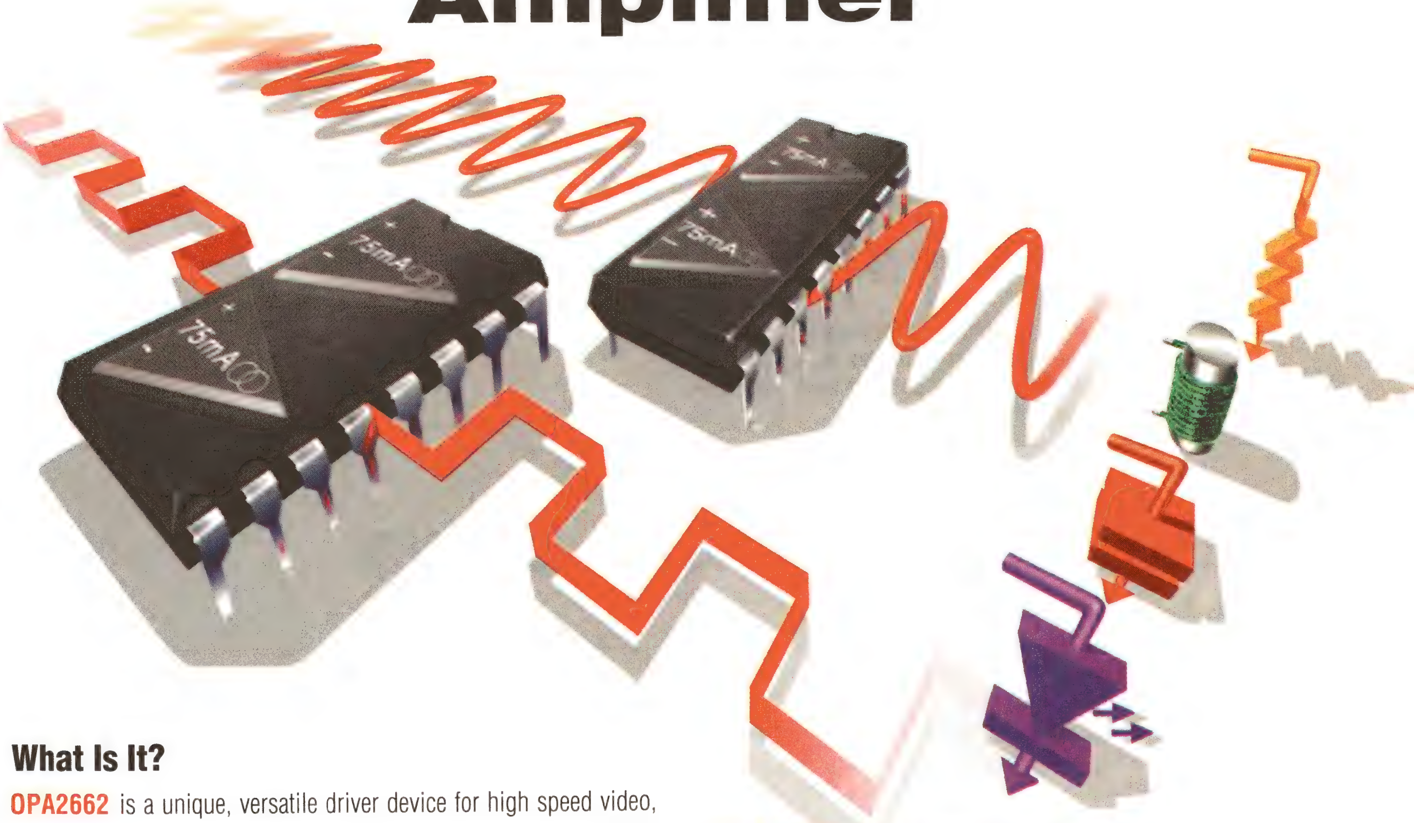
High Speed Operational Transconductance Amplifier



What Is It?

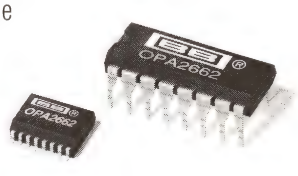
OPA2662 is a unique, versatile driver device for high speed video, broadcast, and communications applications where a load current, rather than a voltage, must be controlled. It combines two voltage-controlled current sources—each can convert an input voltage into output current with up to ±75mA drive capability—or double it by connecting the outputs in parallel. **OPA2662**'s flexibility, power, and low cost make it the driver amp of the future.

Where's It Used?

Use **OPA2662** as a driver amplifier for many kinds of loads—resistive or complex—in applications like magnetic recording heads, RF power output stages, and digital transmission systems. Or, use the enable mode to create a switchable 75Ω/50Ω line driver, or a 2-to-1 or a 1-to-2 multiplexer, or a bi-directional configuration for RF distribution systems. **OPA2662** helps simplify complex signal processing designs—its superior for video systems, a variety of high speed optical applications such as driving LEDs or laser diodes, and data acquisition circuits. Let the power of **OPA2662** drive your next application.

OPA2662 Key Specifications

• Bandwidth	370MHz
• Digital transmission rate	400Mbits/s
• Slew rate (current)	58mA/ns
• Output drive (per channel)	±75mA
• TTL-Enable (on/off-time)	30/200ns
• Packages	16 pin-DIP and SOIC
• Evaluation board available	



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Change improves regulators' reliability

Peter Demchenko, VN, Vilnius, Lithuania

The standard circuit for adjustable, 3-terminal regulators (LM317, LM350, etc) in **Fig 1a** suffers from a designed-in fault: If the potentiometer R_2's wiper loses contact, the regulator's output goes high.

Because the potentiometer is the most unreliable part in the circuit, consider using the circuit in **Fig 1b**. Now, if the potentiometer's wiper loses contact, the circuit's output goes low, and R_3 limits the output-voltage excursion even if the potentiometer shorts out. (DI #1416) EDN

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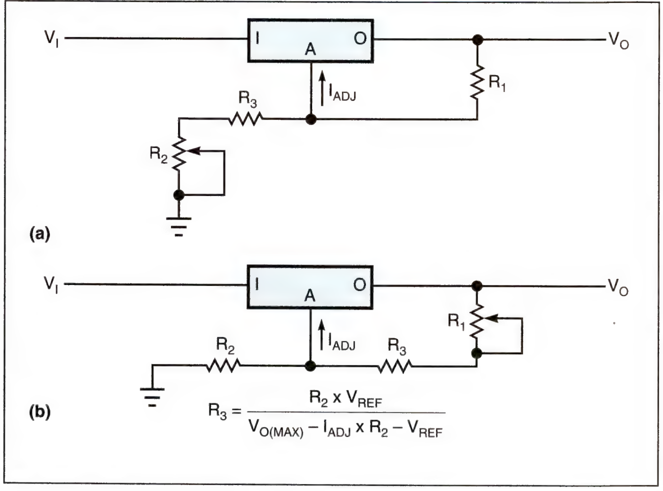

$$R_3 = \frac{R_2 \times V_{REF}}{V_{O(MAX)} - I_{ADJ} \times R_2 - V_{REF}}$$

Fig 1—A simple change in the topology of a 3-terminal regulator's circuit makes the circuit more reliable if the adjusting potentiometer shorts out or if its wiper loses contact.

Instrumentation amplifier has 290-MHz GBW

Paul Hendricks, Analog Devices, Wilmington, MA

The circuit in **Fig 1** combines a dual-matched op amp, IC_1, with a video-difference amplifier, IC_2, to form a high-frequency instrumentation amplifier. **Table 1** shows the circuit's performance for ±5V operation. You can configure the circuit for different gains and operate it using supplies ranging from ±4 to ±16.5V.

Judiciously distributing the circuit's overall gain between IC_1 and IC_2 such that (for a particular configuration) the closed-loop bandwidths of both stages are equal yields a 290-MHz gain-bandwidth product. Preamplifier IC_1's referred-to-input (RTI) voltage noise and dc offset dominate IC_2's RTI voltage noise. Adding capacitor C_1 causes peaking in IC_2's response, which counters IC_1's high-frequency rolloff. Determine the best value for C_1 in your application by Spice simulation or breadboarding.

In this circuit, if IC_1 has a gain of 5 or higher ($A=(2R_F/R_G)+1$), the circuit has an RTI voltage noise of 15 nV/√Hz and an input voltage offset of 600 μV.(DI #1402) EDN

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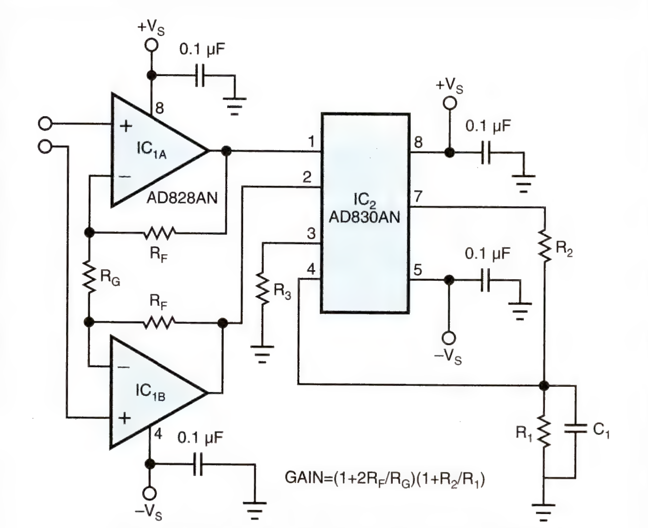


$$\text{GAIN}=(1+2R_F/R_G)(1+R_2/R_1)$$

GAIN	R_F	R_G	R_1	R_2	R_3	C_1 (pF)
10	1050	1050	348	348	169	60
50	1150	255	127	510	100	300

NOTES:

1. ALL RESISTORS ARE 1% METAL FILM.
2. C_1 IS A MICA CAPACITOR.
3. USE 0.1-μF CERAMIC DECOUPLING CAPACITOR AT SUPPLY PIN OF EACH IC.
4. USE 10-μF TANTALUM DECOUPLING CAPACITORS FOR $+V_S$ AND $-V_S$.

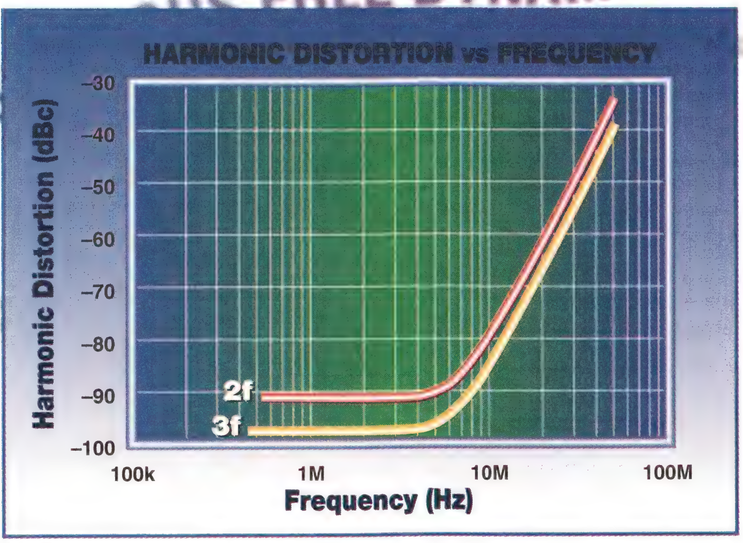
Fig 1—Preceding a video-difference amplifier, IC_2, with a high-performance, matched op-amp stage yields a high-frequency instrumentation amplifier.

Table 1—Performance at ±5

A_V	3-dB bandwidth (MHz)	Slew rate (V/μsec)	Settling time to 0.1% (nsec)	CMRR (dB at 1 MHz)	V_N at 10 kHz (nV/√Hz)	I_N at 10 kHz (pA/√Hz)	V_{OS} (mV)	I_S (mA)
10	14.2	200	80	64	15	1.5	0.6	27.5
50	5.8	60	200	64	15	1.5	0.6	27.5

New Op Amp Delivers 160MHz Bandwidth and 90dB SFDR

90dB SPURIOUS FREE DYNAMIC RANGE



Designed for Low Distortion

OPA628 is a unity gain stable, voltage feedback op amp that delivers 160MHz bandwidth and 90dB SFDR. Its classic op amp design features high input impedance, high common mode rejection, and symmetrical differential input flexibility. Its 90dB SFDR means excellent linearity—better than 1LSB of 15 bits. And, it's powered by ±5V supplies for low power dissipation. Designed for low distortion, OPA628 is your performance choice.

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OPA628's versatility, performance, and low price make it perfect for precision video, telecommunications, instrumentation, and test equipment applications. It's an ideal precision A/D and D/A buffer. It's a great driver for 12- to 16-bit high speed A/Ds. And, its 30MHz gain flatness and very low differential gain/phase error is super for high end video. Or, try it in any application that needs wide dynamic range. Designed for versatility, OPA628 fits your next application.

Designed for Less

OPA628 is designed to give you optimum performance at a super price. It's a better solution than any other "make" or "buy" amp out there. Designed for savings plus performance, OPA628 is the best for less.

OPA628 Key Specifications

Low voltage noise	2.5nV/$\sqrt{\text{Hz}}$
Low noise figure	9.3dB
SFDR	90dBc
Two-tone third-order intercept	60dBm
Supply range	±4.5V to ±6V
Unity-gain bandwidth	160MHz
Differential gain/phase	0.015%/0.015°
Offset voltage	500µV
Packages	8 pin-DIP and SOIC

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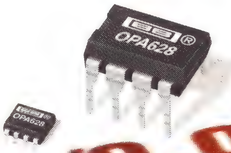

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Video amplifiers make low-cost fader

David Westerman, National Semiconductor, Santa Clara, CA

The circuit in **Fig 1** applies a symmetrical dc control voltage to the contrast inputs of video amplifiers IC_1 and IC_2 to fade from one video source to the other. IC_1's and IC_2's bandwidths handle SVGA or Super Mac (up to 70-MHz) video signals without degradation. For effective fading, both video sources must be locked to each other. The circuit operates from a single +12V supply.

The circuit also has three additional op amps, IC_3, IC_4, and IC_5, to drive coaxial cable. The circuit requires only three ICs if its outputs drive high impedances.

Both IC_1 and IC_2 are in their standard configurations except for their contrast-voltage circuits. R_1 and R_2 set the maximum gain for IC_1 and IC_2, respectively.

A 0 to 4V signal controls contrast, with the maximum gain at 4V. The two 200-kΩ resistors, in series with the contrast potentiometers, limit the maximum contrast-control voltage to 4V. A 0V contrast-control voltage gives a video output 60 dB below the maximum output level. Quad CMOS op amp IC_6 generates the required control voltage for the video fading.

IC_{6A} accepts a TTL input. Its output goes to 12V for a low logic input and to 0V for a high logic input. The output of IC_{6A} goes to IC_1 via R_3 and C_1. This RC network has a time constant of 1 sec, giving about a 3- or 4-sec period for fading. IC_{6C} inverts the output swing of IC_{6B} and is the contrast-control voltage for IC_2. The sum of the outputs from IC_{6B} and IC_{6C} always add to 12V. If you eliminate the RC network, this circuit operates as a video switch.

Referring to IC_1, R_4, R_5, and R_6 balance the gain between the three channels. All control voltages for the IC_1 are 0 to 4V, thus R_7 is in series with the nine trimming potentiometers, limiting the maximum adjustment voltages for IC_1 and IC_2 to 4V. R_8, R_9, and R_{10} set the black level of the video signal to both video amplifiers. You can set IC_1's black level below 0.5V, but if you use a single supply for IC_3, then you should keep the black level above 1V.

For proper dc restoration, you must apply a negative-going clamp pulse to IC_1's pin 14 during the "back-porch" portion of the video signal. Tie IC_1's blank-gate input high because this application does not require the blanking function of IC_1. You can substitute other video amplifiers in this circuit if they have a dc control voltage for contrast.

The output of IC_1 should go to a 390Ω impedance. Looking at the red channel of IC_1, R_{11}, R_{12}, and R_{13} combine to give the correct impedance for IC_1's output. In a monitor, IC_1's and IC_2's outputs can go directly to the cathode-driver amplifiers. (DI #1401) EDN

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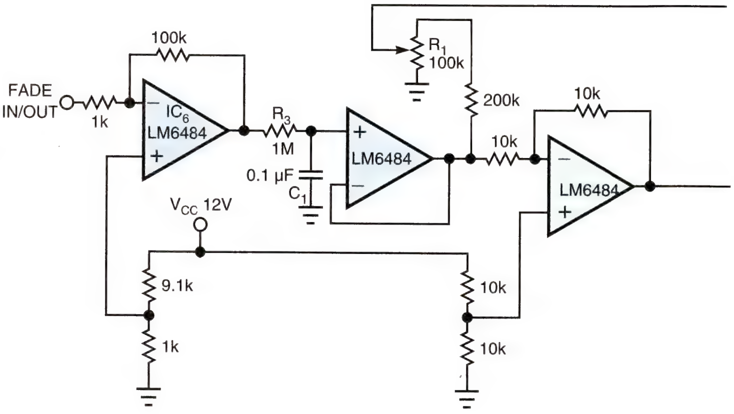
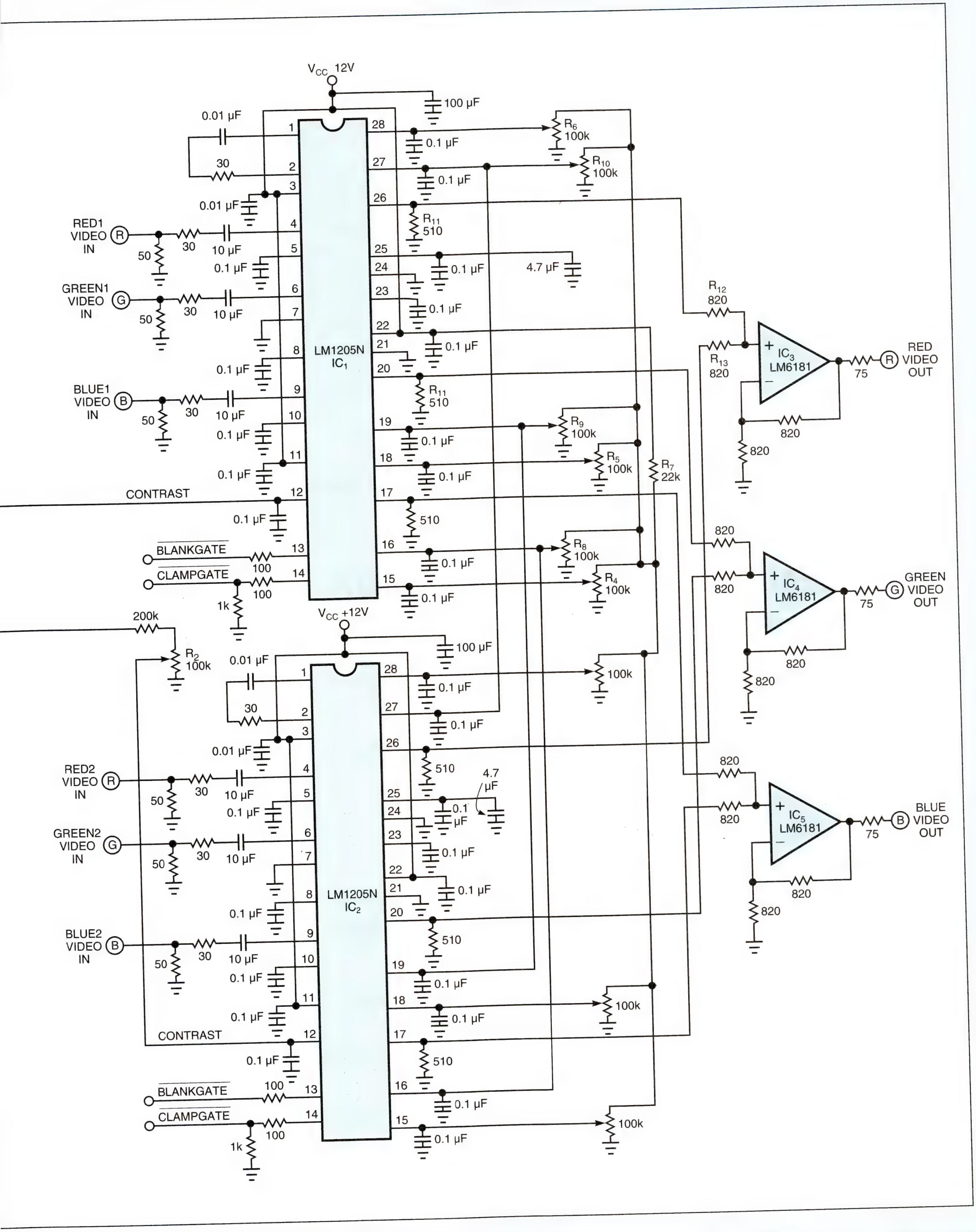


Fig 1—A pair of video amplifiers' contrast controls provides the means to configure a low-cost video fader.


VCC 12V
100 µF
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30
0.01 µF
RED1 VIDEO IN
GREEN1 VIDEO IN
BLUE1 VIDEO IN
50
10 µF
0.1 µF
CONTRAST
BLANKGATE
CLAMPGATE
100
1k
200k
R2 100k
LM1205N IC1
R6 100k
R10 100k
R11 510
4.7 µF
R9 100k
R5 100k
R7 22k
R8 100k
R4 100k
510
R12 820
R13 820
IC3 LM6181
RED VIDEO OUT
75
820
GREEN VIDEO OUT
IC4 LM6181
BLUE VIDEO OUT
IC5 LM6181
VCC +12V
RED2 VIDEO IN
GREEN2 VIDEO IN
BLUE2 VIDEO IN
LM1205N IC2
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Ring oscillator measures cable length

B Enning, Institut für Nachrichtentechnik, Flensburg, Germany

In **Fig 1**, an ECL exclusive-NOR gate (F100107) and a length of cable form a simple ring oscillator. The delay from the cable and the gate determine the ring oscillator's frequency. A 100m cable yields approximately a 600-MHz oscillation frequency. The gate's second output connects to a frequency counter.

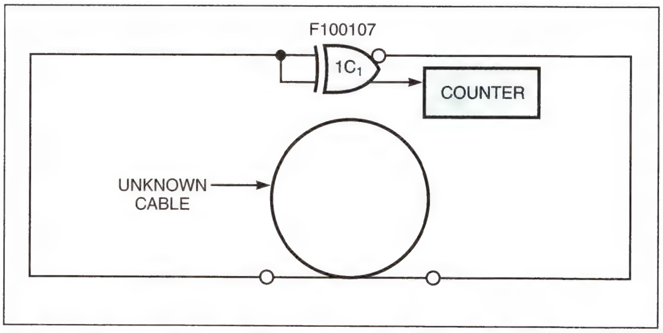

Fig 1—A simple ring oscillator, formed from an ECL gate and an unknown piece of cable, can measure the cable's length.

The gate's delay is the sum of its high-to-low and low-to-high transition times, t_{PHL} and t_{PLH}. Using the period of the ring oscillator, $T=1/f_{OSC}$, the length of the cable (L) is $L=(T/2-(t_{PHL}+t_{PLH}))\times v$, where v is the propagation velocity of the cable. In the case of coaxial cable, $v=1/CZ_0$, where C is the capacitance per unit length and Z_0 is the cable's characteristic impedance.

To test the sensitivity and accuracy of this technique, we spliced short increments of cable into the ring. The setup could accurately measure small changes in length to better than 4% of the length of the added increment (which is accurate to 0.025% of the cable's total length). Be sure to use the proper pull-down resistors for ECL; also, determine if the cable you are measuring actually exhibits its manufacturer's claimed *nominal* impedance. (DI #1420) EDN

To Vote For This Design, Circle No. 365

Precision rectifier is glitch-free to 1 MHz

Dan Stiurca, "Gh Asachi" Technical University, Iasi, Romania

The manufacturer's circuit for a precision, current-mode, full-wave rectifier (**Fig 1a**) converts a voltage signal to a current, eliminating errors arising from voltage drops across the rectifying diodes. However, just like op-amp-based rectifiers, the circuit in **Fig 1a** requires closely matched resistors.

The circuit in **Fig 1b** obviates the precision resistors by simply returning the diodes to the input. For a positive signal current, D_1 is on, and the current flows into the load resistor to develop an output voltage.

When the input signal current is negative, D_2 is on, passing current to the low-impedance input X of current-conveyor PA630, IC_1 (Photonics, Manotic, ON, Canada, (613) 652-2247). IC_1 conveys this current via its high-impedance output Z to the load. This current flows in the same direction as current that D_1 passes because IC_1 inverts current flows. The circuit provides glitch-free performance up to 1 MHz. (DI #1426) EDN

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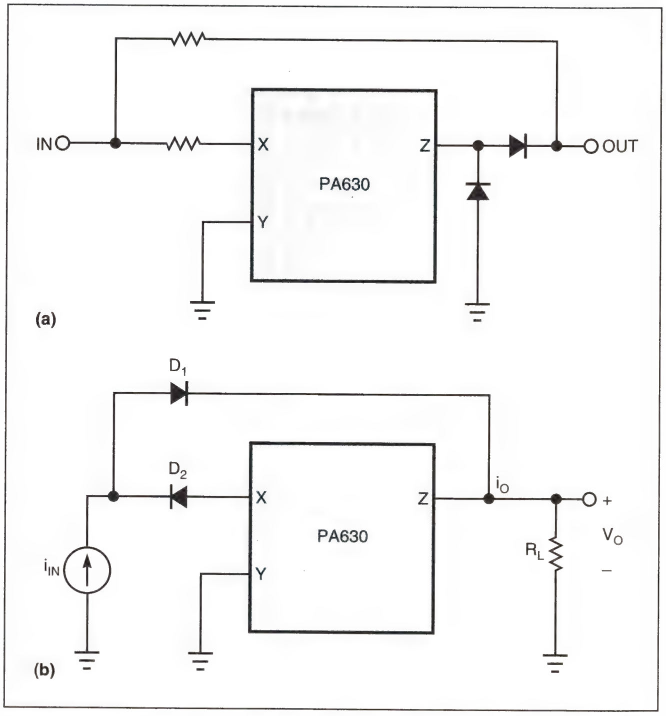

Fig 1—Unlike the manufacturer's circuit in (a), the circuit in (b) obviates precision resistors yet provides glitch-free performance up to 1 MHz.

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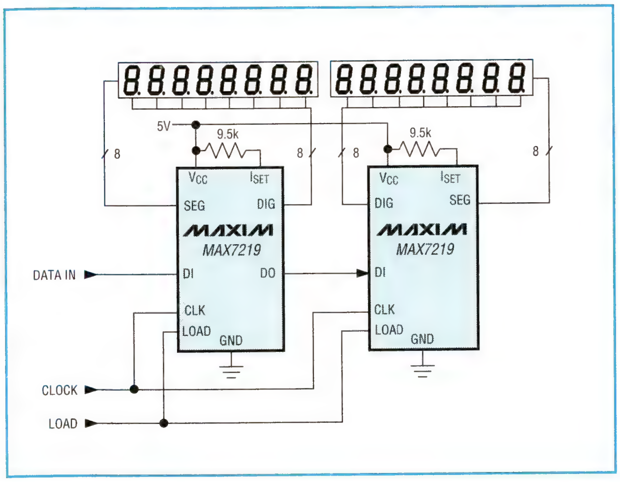
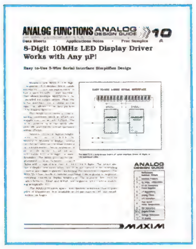
- **7-Segment or No-Decode Selectable for Each Digit**
- **24-Pin Narrow DIP or SO Packages**



The MAX7219's easy-to-use, 3-wire, µP serial interface drives 16 digits or 128 individual LEDs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CIRCLE NO. 149

F/V converter has high accuracy

Paul Hendricks, Analog Devices Inc, Wilmington, MA

The high-accuracy frequency-to-voltage converter (FVC) in **Fig 1** demonstrates how a synchronous, charge-balance, voltage-to-frequency converter (VFC) can function as a single-supply FVC given proper biasing and level shifting. This FVC can maintain a monotonic 0.01% linearity error over a 60-dB range of 9.7 kHz to 9.7 MHz; it operates from 12 to 36V power supplies. You can modify the circuit's prescaler to adapt the circuit to considerably higher frequency ranges.

Because synchronous VFCs, such as IC$_4$, use an external timing element (C_{INT}) to define the full-scale output frequency, they achieve both greater linearity (<0.005%) and temperature stability than do nonsynchronous, charge-balanced VFCs or astable-multivibrator VFCs.

In operation, **Fig 1**'s circuit, a TTL-level input signal of varying frequency feeds a divide-by-10 prescaler, IC$_1$, to bring the input frequency within synchronous-VFC IC$_4$'s 1-MHz range. The output of the prescaler feeds a synchronizing circuit comprising IC$_2$'s flip-flops and associated components. IC$_2$'s flip-flops synchronize the edges of the scaled input signal with edges of the 2-MHz external-system clock, f_{CLK} (f_{CLK} also drives the VFC, IC$_4$).

IC$_4$ must have the input signal's edges synchronized with the system clock's. Otherwise, IC$_4$'s internal digital circuitry could miss an edge of an input signal having a very low—or very high—duty cycle.

The synchronized signal goes to npn transistor Q$_1$, which provides level shifting to trigger the internal comparator of the VFC IC$_4$ (pin 10). Diodes D$_1$ and D$_2$ clamp the output of Q$_1$ to the 5V supply, limiting the range of Q$_1$'s output.

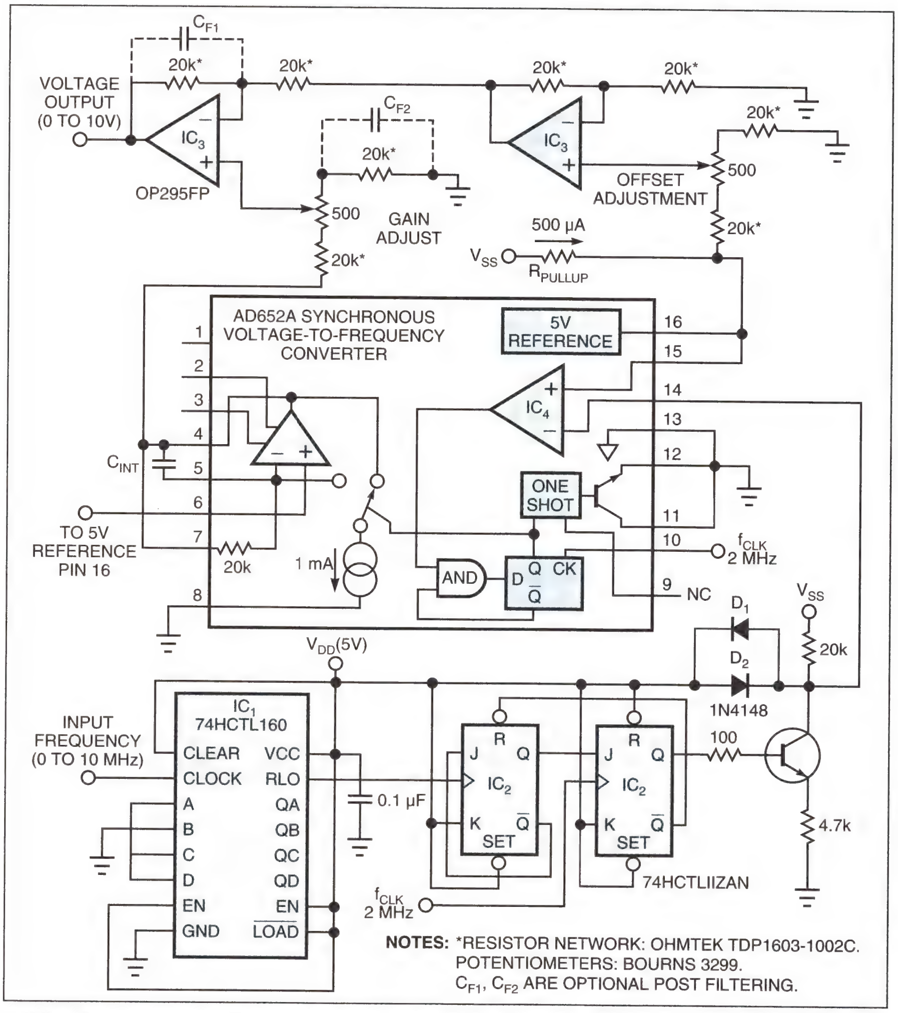
IC$_4$'s internal AND gate and flip-flop switch the chip's 1-mA current source on and off at the rate of the scaled, synchronized input signal. C_{INT} along with IC$_4$'s internal op amp's 20-kΩ resistor integrate the 1-mA current pulses, producing a voltage output proportional to the input's frequency.

You must bias IC$_4$'s internal op amp's common-mode voltage (pin 6) and its comparator's reference (pin 15) to 5V or greater. The circuit uses IC$_4$'s internal reference to bias these pins. Size R_{PULLUP} so that it carries 500 µA. With this biasing scheme, the voltage output from IC$_4$'s internal op amp (pin 4) has a 10V full-scale output span (using the internal 20 kΩ resistor) *relative* to its own signal reference.

The value of integrating capacitor C_{INT} determines the inherent tradeoff between the VFC's settling time and the ripple voltage on its voltage output (pin 4). For example, plugging in a 1-µF capacitor results in a desirably low-ripple output voltage at the expense of a slow response to an instantaneous change in input frequency.

A pair of single-supply op amps level-shifts the voltage output of IC$_4$ from its 5V signal-reference point (pin 6) to the system ground. The op amps' configuration enables both fine-gain and offset-trim adjustments. The voltage output of op amp IC$_3$ (pin 1) has a 10V output swing relative to the system ground for a full-scale input-frequency range of 10 MHz.

A thin-film-resistor network maintains the overall circuit's low gain drift of 35 ppm/°C. You can add post-filtering of the output's ripple voltage. The low end of the dynamic range of the FVC is limited to the output-swing capabilities of the op amp, approximately 5mV. (DI #1422) EDN



NOTES: *RESISTOR NETWORK: OHMTEK TDP1603-1002C.
POTENTIOMETERS: BOURNS 3299.
C_{F1}, C_{F2} ARE OPTIONAL POST FILTERING.

Fig 1—A synchronous charge-balance voltage-to-frequency converter (VFC), IC$_4$, forms the heart of this high-accuracy, single-supply, frequency-to-voltage converter (FVC).

To Vote For This Design, Circle No. 367

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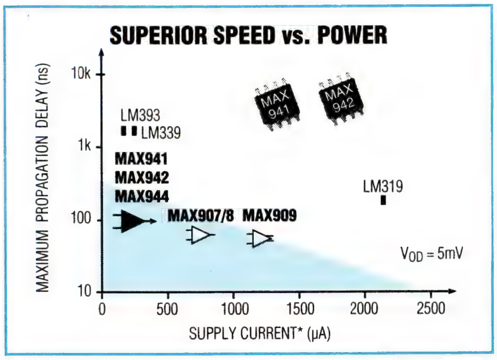

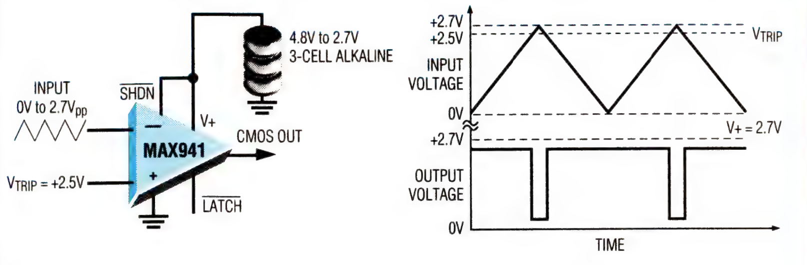

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NEW	MAX944	Quad	100	350	2.7	-200mV to 5.2V	$2.50
	MAX907	Dual	50	700	5	-200mV to 3.5V	$1.70
	MAX908	Quad	50	700	5	-200mV to 3.5V	$2.95
	MAX909	Single	50	1200†	5	-200mV to 3.5V	$1.50

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CIRCLE NO. 34

SOFTWARE SHORTS

3-component circuit accurately measures temperatures

Jim Hartmann, Silent Knight Security Systems
Maple Grove, MN

The inexpensive circuit in **EDN BBS /DI_SIG #1419** accurately measures temperatures using NTC thermistors. The circuit requires two bidirectional CMOS I/O pins of a µC or expansion port. The circuit employs a precision resistor and a capacitor in addition to the thermistor.

To Vote For This Design, Circle No. 368

Display decoder works upside down

Jerzy R Chrząszcz, Institute of Computer Science
Warsaw University of Technology, Warsaw, Poland

The 22V10 PLD program for a hex-to-7-segment converter in **EDN BBS /DI_SIG #1404** has an unusual feature: The converter can display digits either right side up or upside down.

To Vote For This Design, Circle No. 369

Utility freezes FPGA pin locations

Clive Bolton and Jean Coté, Bolton Engineering Inc
Melrose, MA

The C utility FREEZEPN in **EDN BBS /DI_SIG #1405** takes a Xilinx field-programmable gate-array (FPGA) (XC3000 and XC4000 series) fitter file (APR or PPR) and creates a design-constraints file (.CST) to freeze pin locations or pin and CLB locations.

To Vote For This Design, Circle No. 370

Method quickly computes square roots

Ashfaq A Khan, Xerox Corp
El Segundo, CA

The algorithm in **EDN BBS /DI_SIG #1406** computes single-precision floating-point square roots using only integer-multiply and shift instructions, yielding results five times faster than library routines do.

To Vote For This Design, Circle No. 371

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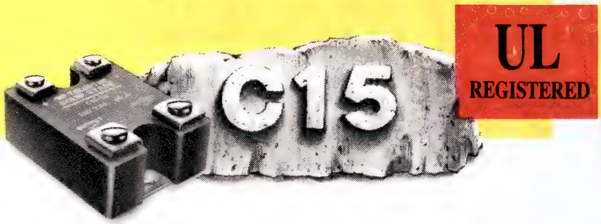

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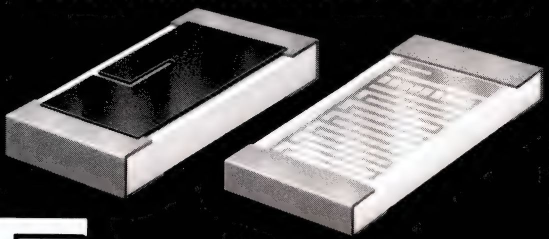

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DESIGN NOTES

5V to 3.3V Regulator with Fail-Safe Switchover – Design Note 82

Mitchell Lee

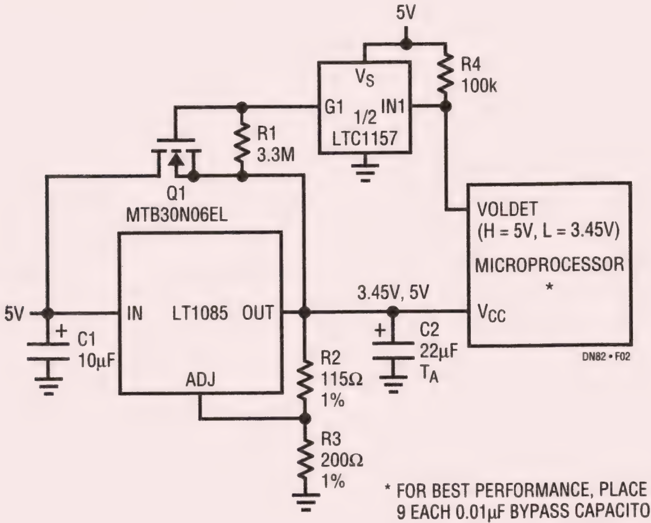
Newer microprocessors in personal computers have low voltage chips which are designed to replace existing 5V units. In the past a processor swap was simply a matter of removing one IC and replacing it with an updated version. But now the upgrade path involves switching from a 5V chip to one that requires 3.xxV.

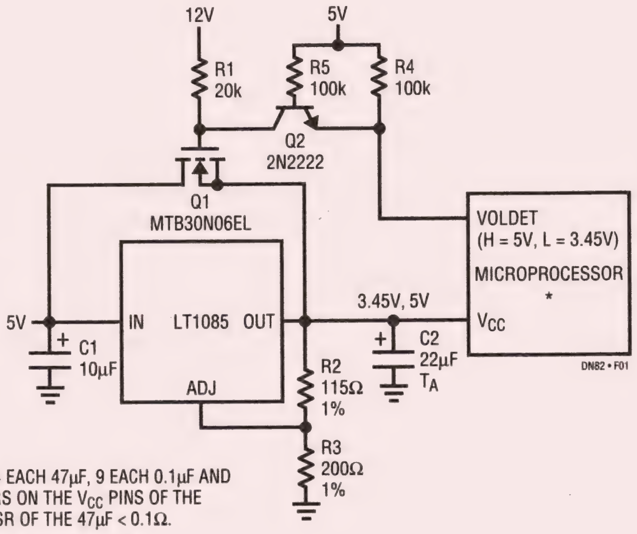
One means of changing supply voltage from 5V to 3.xxV is to clip a jumper that bypasses a local 3.xxV regulator. This is not a good solution since it leaves too much to chance. Failure to remove the jumper can result in the instant destruction of the new microprocessor upon application of power. A means of automatically sensing the presence of a 3.xxV or 5V processor is necessary.

Intel microprocessors include a special pin called "VOLDET" which can be used to determine whether or not a particular chip needs 3.xxV or 5V. Figure 1 shows a simple circuit that takes advantage of this pin to automatically "jumper out" a 3.xxV regulator whenever a 5V processor is inserted into the socket. VOLDET is pulled low on 3.xx processors; it is buffered by transistor Q2 which grounds the gate of a bypassing switch (Q1). Q1 is turned off leaving the LT1085 to regulate the microprocessor's V_{CC} line.

For 5V microprocessors the VOLDET pin is high; Q2 is turned off allowing Q1's gate to pull up to 12V, turning itself on. With the LT1085 shorted from input to output by the MOSFET, 5V flows directly to the microprocessor. No service intervention is required to ensure correct V_{CC} potential.

The circuit in Figure 1 is fine for cases where 12V is available to enhance the MOSFET switch. However, in portable applications, 12V is frequently not available or available only on an intermittent basis. Figure 2 shows a second solution using a high-side gate driver to control the MOSFET. A VOLDET pull-up resistor is required in both figures because in some cases VOLDET





* FOR BEST PERFORMANCE, PLACE 4 EACH 47µF, 9 EACH 0.1µF AND 9 EACH 0.01µF BYPASS CAPACITORS ON THE V_{CC} PINS OF THE INTEL 486™ MICROPROCESSOR. ESR OF THE 47µF < 0.1Ω.

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Figure 1. Bypass Circuit for 3.xxV and 5V Microprocessor Swaps Using Transistor Buffer

Figure 2. Bypass Circuit for 3.xxV and 5V Microprocessor Swaps Using High-Side Gate Driver (No 12V Supply Required)

Circle No. 53

is an open circuit or a shorting link, and in other cases it is an open-drain output.

VOLDET is pulled up to 5V in both circuits. This could pose a problem for 3.xxV processors with open-drain VOLDET pins, but for 3.xxV devices VOLDET is always pulled low and 5V never reaches it. The 5V reaches VOLDET only on 5V devices.

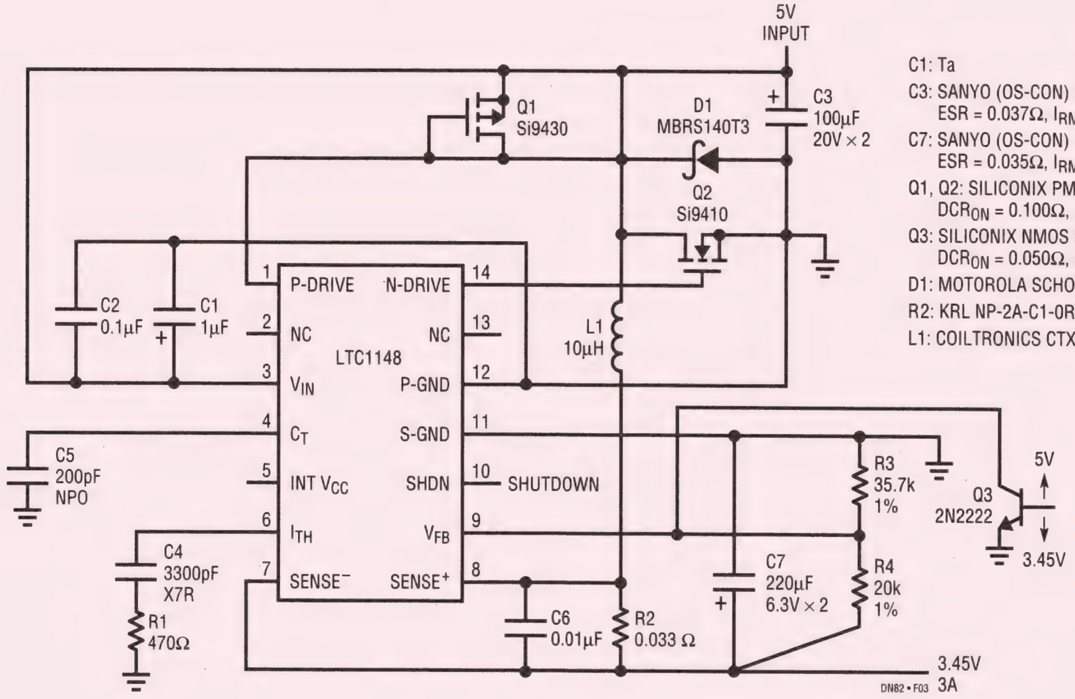
For certain families of microprocessors, 3.3V is required. The circuits shown in Figures 1 and 2 are fully compatible with 3.3V applications by simply substituting a fixed 3.3V version of the regulator (use an LT1085-3.3). Higher current operation is also possible. The LT1085 is suitable for 3A applications; use an LT1084 and an MTB50N06EL for up to 5A. Table 1 shows the wide range of linear regulators available at currents of up to 10A.

In some applications the complexity of a high efficiency switching regulator may be justified for reasons of battery life. Figure 3 shows a switcher that not only converts 5V to 3.45V but also acts as its own bypass switch for applications where a 5V output is required. An open drain or collector pulling the V_{FB} pin low causes the top side P-channel MOSFET to turn on 100%, effectively shorting the output to the 5V input. If the open collector is turned off, the LTC1148 operates as a high efficiency buck mode power converter, delivering a regulated 3.45V to the load. For 3.3V applications a fixed 3.3V version of the LTC1148 is available.

Table 1. Linear Regulators for 5V to 3.3V Conversion

LOAD CURRENT	DEVICE	FEATURES
150mA	LT1121-3.3	Shutdown, Small Capacitors
700mA	LT1129-3.3	Shutdown, Small Capacitors
800mA	LT1117-3.3	SOT-223
1.5A	LT1086	DD Package
3A to 7.5A	LT1083 LT1084 LT1085	High Current, Low Quiescent Current at High Loads
10A	2 × LT1087	Parallel, Kelvin Sensed

The topic of powering low voltage microprocessors in a 5V environment is covered extensively in Application Note 58, available on request. Both linear and switching solutions are discussed.



C1: Ta
C3: SANYO (OS-CON) 20SA100M, ESR = 0.037Ω, I_{RMS} = 2.25A
C7: SANYO (OS-CON) 10SA220M, ESR = 0.035Ω, I_{RMS} = 2.36A
Q1, Q2: SILICONIX PMOS BV_{DSS} = 20V, DCR_{ON} = 0.100Ω, Qg = 50nC
Q3: SILICONIX NMOS BV_{DSS} = 30V, DCR_{ON} = 0.050Ω, Qg = 30nC
D1: MOTOROLA SCHOTTKY VBR = 30V
R2: KRL NP-2A-C1-0R020J, P_D = 1W
L1: COILTRONICS CTX10-4

Figure 3

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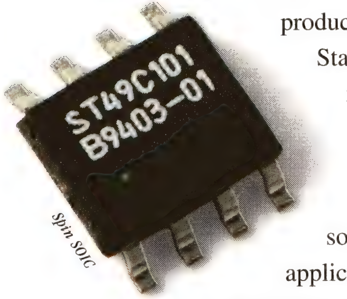

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ST49C155	Mother Board Clock Up To 8 Outputs	20 PDIP/SOIC
ST49C214	Dual Clock Output Up To 20 Freqs.	20 PDIP/SOIC
ST49C104	Single Clock Output	8,14 PDIP/SOIC
ST49C154	Mother Board Clock	16 PDIP/SOIC
Drivers/Receivers		
ST31C32	3,5 RS422/423 Transceiver	28 PDIP/SOIC/PLCC
ST34C87/26C31	Quad RS422 Differential Line Dr.	16 PDIP/SOIC
ST3486/26C32	Quad RS422/423 Differential Line Rec.	16PDIP/SOIC
ST34C50/34C51	Dual RS422/423 Transceiver	16 DIP/SOIC
UARTS		
ST16C550	UART w/FIFO	40 PDIP/44 PLCC
ST16C552	DUART w/FIFO/Printer	68 PLCC
ST16C553	DUART w/FIFO/Printer w/FIFO	68 PLCC
ST16C2550	DUART w/FIFO	40 PDIP/44 PLCC
ST16C554/68C554	Quad UART w/FIFO	68 PLCC
Peripherals		
ST37C65	Floppy Controller	40 PDIP/44 PLCC
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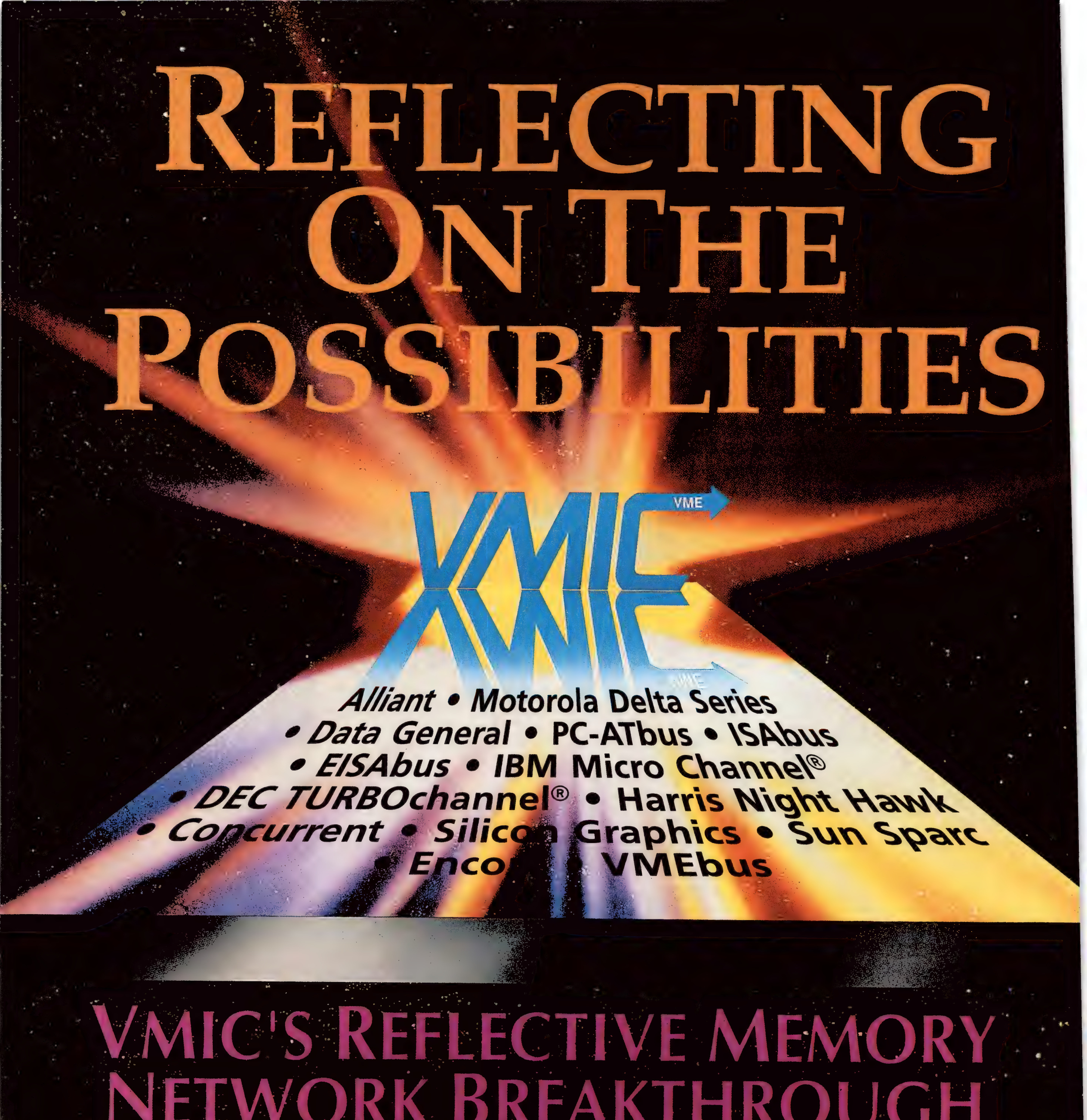
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Internal debuggers simplify µP pc-board verification

Jim Hebert, Tektronix Inc

When you must keep the cost of a design to a minimum, try using µPs having background-debug mode, which reduces parts count, lowers board cost, and improves reliability.

Until recently, engineers have lived with a basic limitation of µP-board design: the inability to inspect or directly control the internal workings of the actual µP. This limitation was especially irritating when the core system crashed, rendering onboard diagnostic software unusable. Unable to run even the most rudimentary diagnostic software, engineers resorted to intelligent guesswork or used a costly in-circuit emulator (ICE).

To address this µP-access limitation, a new generation of µPs includes a background-debug mode that provides an independent port directly into the µP. Besides reducing the need for ICEs, background-debug mode can also streamline critical design and manufacturing tasks.

By incorporating a µP with background-debug mode into a design, you can directly perform a range of functions that previously required resources external to the µP. First and foremost, background-debug mode enables you to take a structured approach to design verification and debugging. Background-debug mode's usefulness goes beyond troubleshooting to include a variety of applications that range from bringing up prototype boards to inspecting error logs during manufacturing and field servicing.

ICE limitations

ICEs are powerful tools for debugging and verifying µP-based designs. But, because emulators are expensive, project managers usually purchase only a few to share among a team of engineers.

ICEs have some severe limitations; and although they give you access to the inner workings of the µP, they introduce a new layer of complexity and cost for both design and manufacturing. Emulators can either create or mask µP problems. When a system failure occurs with an installed emulator, you must first determine if the emulator induced the failure or if the problem actually stemmed from a real flaw.

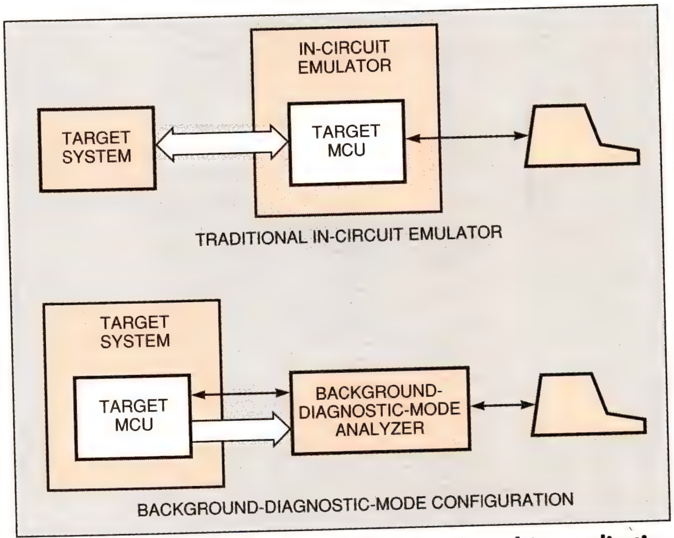
In addition, installing an emulator during verification or manufacturing may be difficult. Most problems at these stages are specific to a particular µP board or its µP, and not the design itself. So removing the µP and adding a socket for an emulator can subtly change the problem—or even make the problem magically disappear.

Background-debug-mode µPs

You can eliminate the need for ICEs by incorporating the new type of µP with background-debug mode. Using a background-debug-mode µP, you can directly monitor and interact with the µP at any stage of design or manufacturing without having to resort to an ICE. **Fig 1** shows how a µP with background-debug mode simply monitors the traffic on the µP's internal bus. In contrast, an ICE replaces the µP in the target system. Therefore, all of the µP's external bus traffic must traverse the cable between the emulator and the target system, possibly altering timing or the system's electrical characteristics.

To provide a window into the µP's activities, the background-debug-mode µP contains a debugger in its microcode and a dedicated serial-debug port.

In a design with background-debug mode, you can view and alter the core µP system directly, including the µP's internal registers, external RAM and EEPROM, and buses. The hardware and software requirements are simple and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TARGET SYSTEM
TARGET MCU
BACKGROUND-DIAGNOSTIC-MODE ANALYZER
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Fig 1—A µP having background-debug mode and its application software can replace a traditional in-circuit emulator.

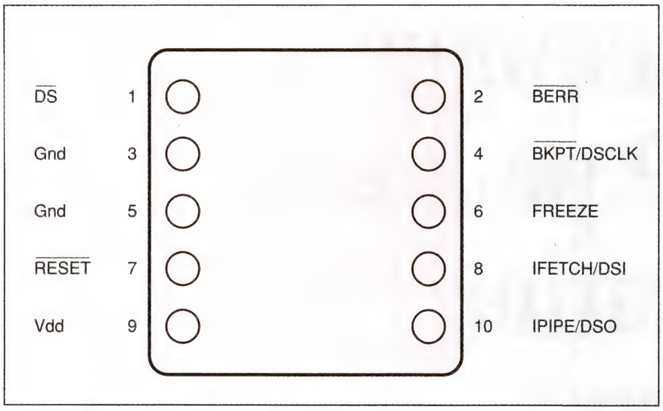

Fig 2—To accommodate background-debug mode, you need only add this 10-pin connector to your μP board's design.

straightforward for background-debug mode. The physical link between a background-debug-mode μP and a controlling PC is a simple 2×5-pin connector mounted on the μP board (**Fig 2**).

The μP's manufacturer supplies a special interface cable to connect to a PC along with software for communicating while in the background-debug mode.

The background-debug-mode software resident on the PC has the look and feel of ROM-resident debugger code. The software provides all of the expected debugging functions, such as modifying memory, downloading code, and starting execution. It can also use the PC's serial port to send and receive synchronous serial data. Additional debugging capability is possible if you include a breakpoint IC in your board's design. But to use such a breakpoint IC, all data, addresses, and control buses have to be connected and operational.

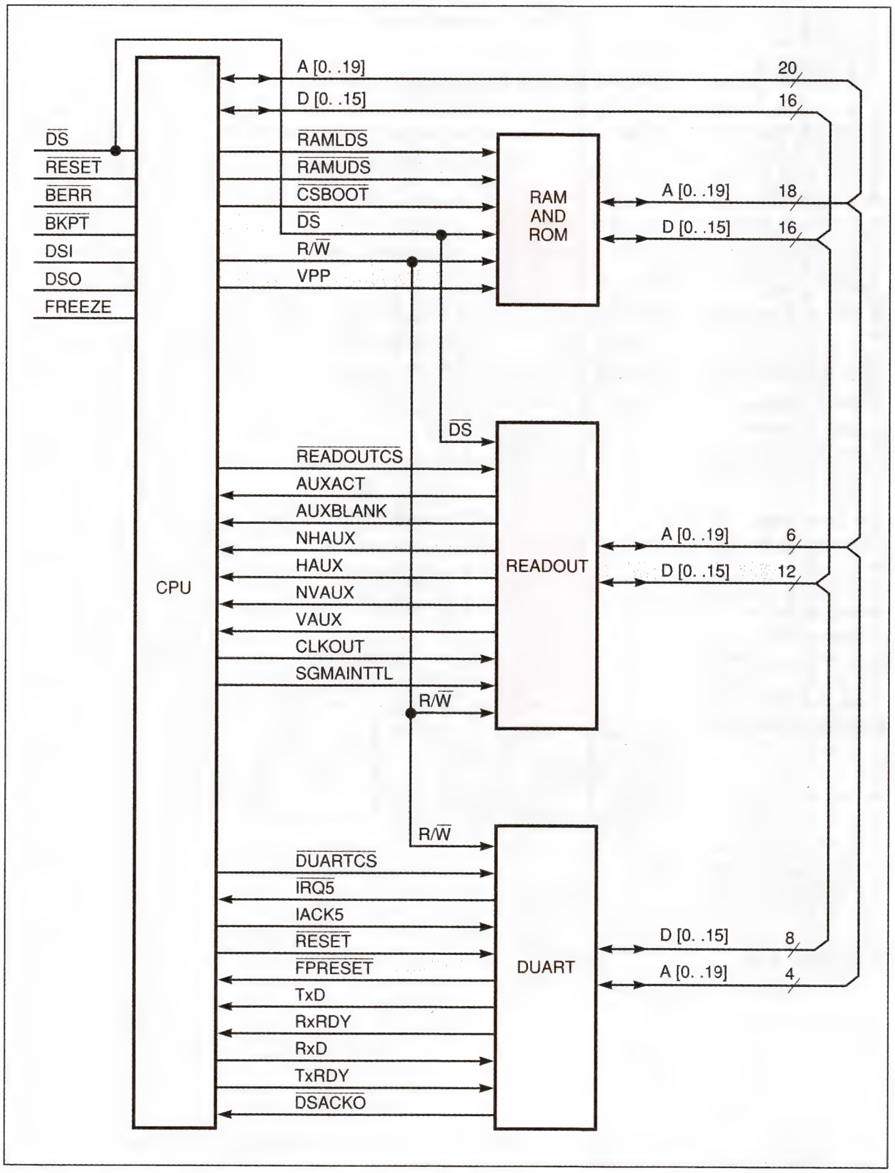

Fig 3—Only the seven additional signals in the upper-left corner of the diagram are necessary to facilitate background-debug mode in this CPU board.

A μP-design example

As an example, the Tektronix TAS 400 series of analog oscilloscopes uses a μP with background-debug mode. These oscilloscopes' CPU boards are generic enough to be applicable to almost any basic microcontroller design; **Fig 3** shows that TAS 400's CPU board is a 4-block design.

This board contains a μP, some memory, a dual asynchronous receiver/transmitter (DUART), and a custom readout IC. The RAM and flash EEPROMs have 256-kbyte capacity (you could easily increase capacity to 512 kbytes). The DUART performs timing and communication; the custom-readout IC serves as a character display for diagnostic purposes.

For this design, Motorola's MC68331 μP with background-debug mode works well. In this application, the μP has the common support circuitry—such as a reset circuit, input pull-ups, and a system clock—of most μP designs. This μP requires all the typical communications signals along with seven additional signals for the background-debug mode: DS, BERR, BKPT/DSCLK, FREEZE, RESET, IFETCH/DSI, and IPIPE/DSO.

Bring up a new board

When first bringing up a system, reading or writing memory is sometimes impossible. A variety of potential problems can cause this fundamental failure—sometimes several occur simultaneously. Problems can stem from a simple wiring or design error or possibly from a short between connections. But the source of the problem can

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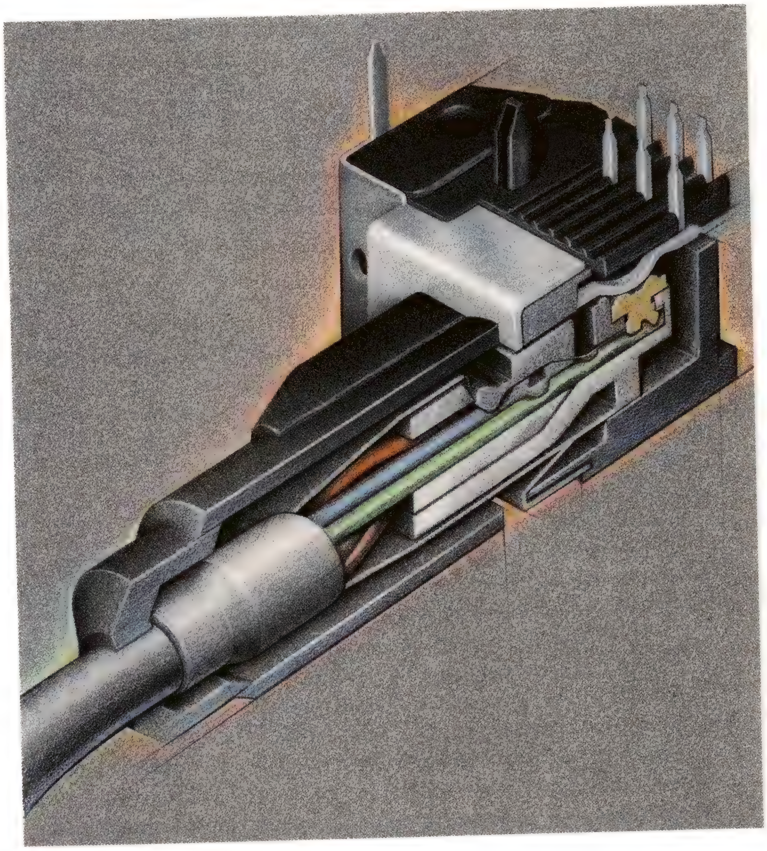

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be more complicated, such as a bad I/O port or even the software of the debug monitor.

A first pass at debugging involves checking the voltages on all the ICs, the clock lines, the reset signal, and the other easily viewed signals. If these checks fail to reveal the problem, some method of generating bus transactions to view the address, data, and control lines in operation is necessary (**Fig 4**).

In the past, engineers added ROM sockets to the board for debugging and then burned small program loops into the ROMs. ROM-burn iteration and output inspection located the problem.

A μP with background-debug mode provides a more efficient and direct approach to troubleshooting prototype failures. By simply connecting the background-mode port and starting its associated PC software, an engineer can use a PC to isolate each IC on the board systematically. In background-debug mode, the μP queries individual ICs to test the quality of the communications link between the μP and the IC. This systematic approach allows verifying that the board's hardware works without having to invoke its own software.

Once you check the μP and peripheral ICs, you can use the background-debug mode to verify that the software did indeed correctly configure the μP's internal registers. Background-debug mode significantly simplifies bringing up a new μP board by dividing the complex problem of initial board failures into a series of small problems that you can solve easily.

Finding faulty components

An engineer can also rely on background-debug mode to locate μP-board power-up problems quickly. Often, a μP board doesn't boot up when critical components fail.

To troubleshoot this problem, engineers typically have used an oscilloscope and the diagnostics that reside in ROMs on the μP board. But to execute these diagnostics, most μP systems require the μP, ROM, RAM, and data and address buses to be fully functional and error free. Hardware problems that shut down these basic operations force you to rely on trial and error to locate faulty hardware components, replacing parts until the system works.

To overcome this debugging limitation when the core system is not fully operational, you can easily inspect the μP's internal registers and immediate peripherals. Using this approach, you can independently verify each component's register contents and response to μP commands.

Programming flash EEPROMs

When designing μP-based, portable products, you must pay particular attention to parts count and cost. Although flash EEPROMs are extremely advantageous for these types of designs, they typically require a special boot ROM that contains download/erase code. But if the design includes a μP with background-debug mode, the download/erase code can reside on a PC. And you can eliminate the boot ROM.

To program the flash EEPROMs, you simply connect to the background port and download the EEPROM-burning code into the board's system RAM. After starting the EEPROM-burning code's execution via the background-debug-mode port, the code queries the PC for the firmware file. The burn code copies bytes of the firmware from the PC into a buffer in the system RAM. The burn code then uses an application-specific flash-burn algorithm to write from the buffer into the flash EEPROM. The burn code fills the buffer and repeatedly burns the code until it has written all of the firmware file.

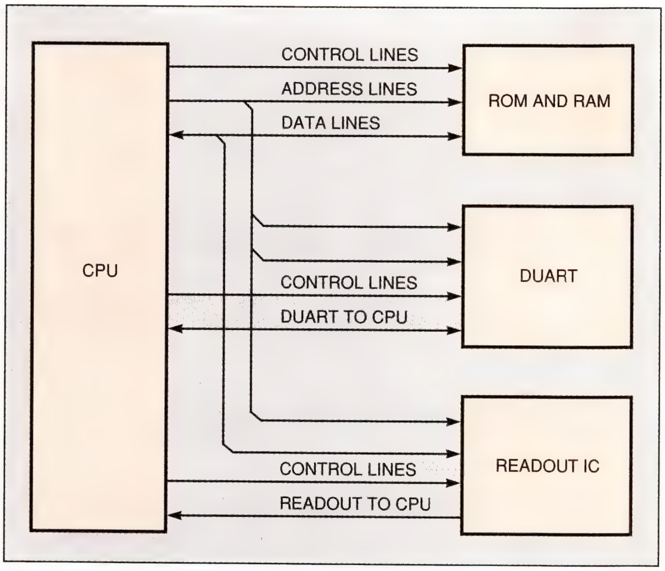

Fig 4—To debug a prototype μP board, you typically need to observe transaction on the data, address, and control lines in the core system.

Inspect error logs

Typically, engineers do not include a communications port in a finished design because the port adds complexity and cost. But when your customers return defective products to your factory, you must analyze these products to understand the failure—and eliminate it in future products. To perform this analysis, you may need to access the the device's internal operations.

If the design does not include a conventional communications port in the finished product, use background-debug mode as a port for error-log inspection. Often, μP-based systems contain diagnostic routines, which perform periodic self-evaluations, storing the results in nonvolatile memory. The results of these evaluations are often useful in failure analyses. Instead of having to use an ICE or install a communications port into each returned product, you can access and display the error log using background-debug mode.

Author's biography

James Hebert is an engineer at Tektronix in Beaverton, OR. He has worked for Tektronix for six years, designing hardware and writing embedded firmware. He obtained a BSEE from Washington State University and is working on an MBA at the University of Oregon. In his spare time, he enjoys water-skiing.

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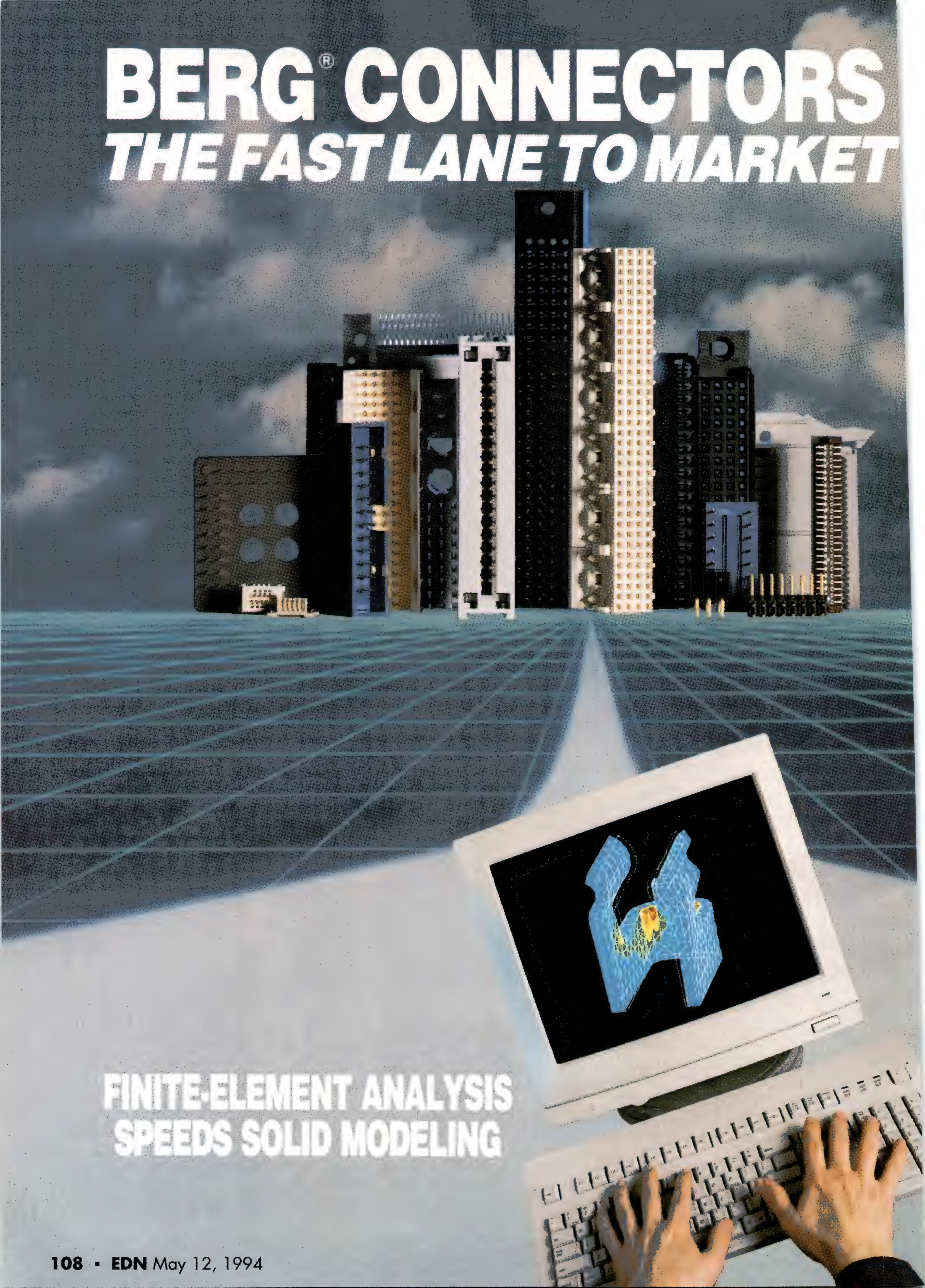
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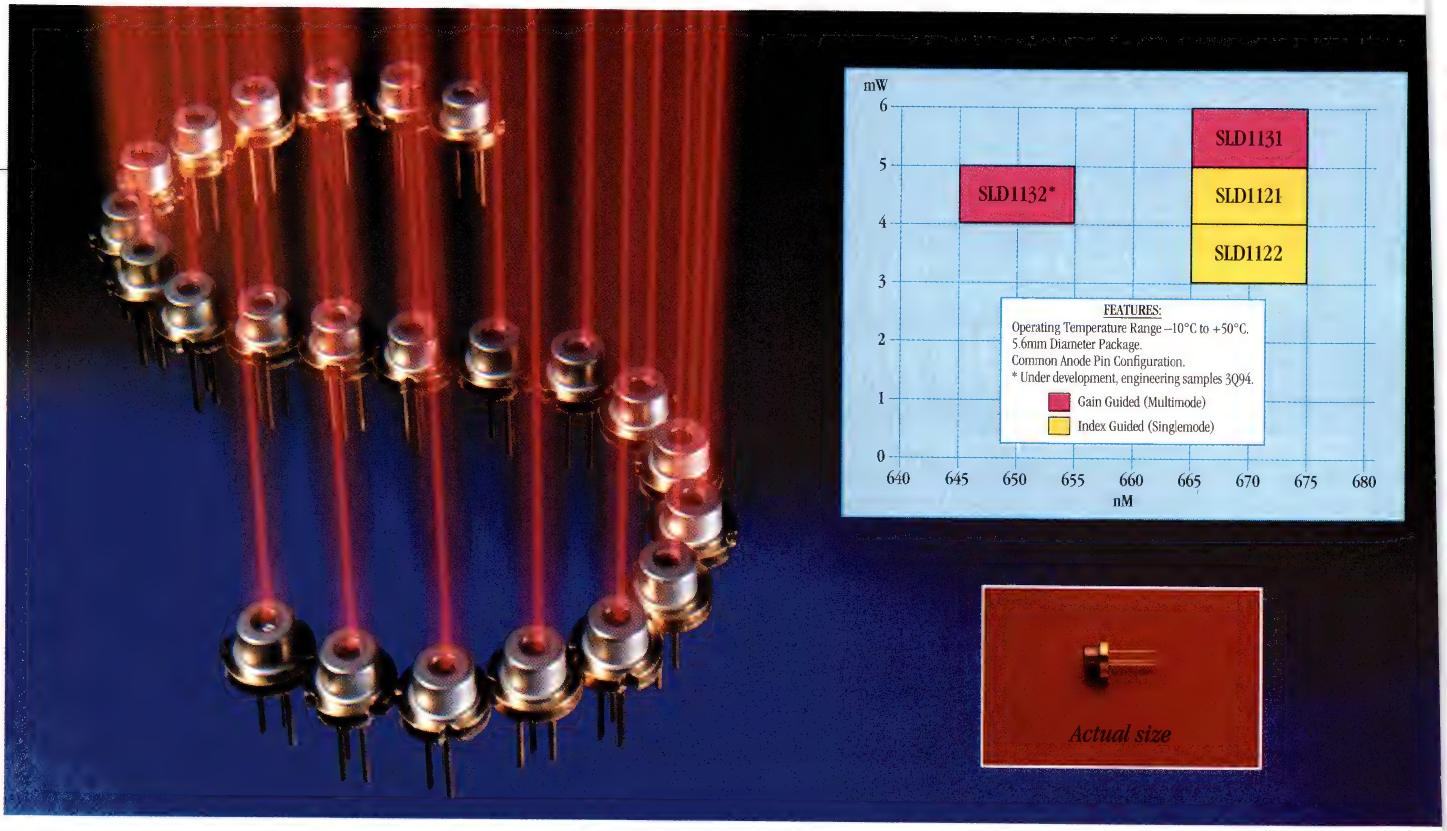

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Transition maps guide successful asynchronous state-machine design

Ricardo O Rabinovich, Ascom Timeplex Inc

To avoid the risks of asynchronous logic, designers too often sacrifice system performance by using synchronous designs. Transition maps, however, help designers avoid the risks in asynchronous logic—and recover lost performance.

While ASIC houses and "good engineering practices" emphasize synchronous-design techniques, the increasing use of clock speeds as fast as 50 to 200 MHz is forcing designers to implement asynchronous logic circuits, instead. Unfortunately, although most digital design engineers are familiar with combinatorial and synchronous sequential-logic circuits, the world of asynchronous sequential logic design remains obscure. Transition maps can guide designers through this unfamiliar world to reach reliable asynchronous designs.

The journey begins with some basic concepts and definitions. Digital circuits can be classified as either combinatorial or sequential. Combinatorial circuits are those with output values that depend exclusively on the input signal levels. Sequential circuits have output values and present-state values that depend not only on the present input values, but also on the circuit's previous state.

You can group sequential circuits into two types: synchronous and asynchronous. In synchronous circuits, the present state changes on the edge of a clock (**Fig 1a**). The present state in asynchronous circuits changes upon a transition in one or more input variables followed by the circuit's propagation-delay period (t_{pd}).

When creating sequential asynchronous logic circuits, pay careful attention to the propagation delays through the circuit. Otherwise, undesirable output glitches or even permanent undesirable states can occur. To avoid the hazards of asynchronous circuits, designers opt for synchronous implementations more often than necessary.

Synchronous circuits, however, also have inherent problems. Designers must synchronize input signals to the state-machine clock to avoid metastable conditions. Further, changes in input values affect the output values only after the synchronizing clock occurs, increasing the time needed for the circuit to react (ie, latency). Clocking latency and the need for input-signal synchronization can seriously degrade a system's performance.

Fig 1b is a block-diagram model for an asynchronous sequential-state machine. The model consists of a combinatorial logic block with output signals that determine the next-state values. The block's input variables are the external input signals and present-state variables. The model assumes that the combinatorial logic has no propagation delay and that the present-state variables take on the next-state variable's values after a settling time. The settling time

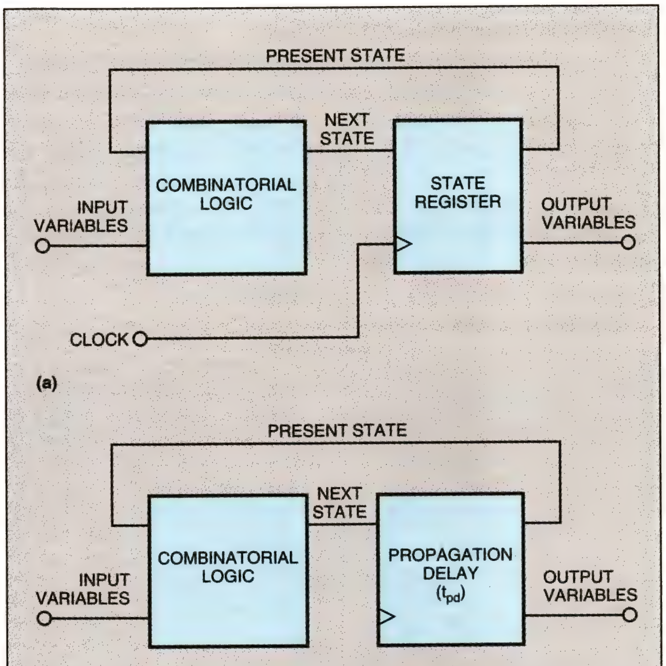

Fig 1—The behavioral design models for synchronous (a) and asynchronous (b) circuits are nearly identical. The main difference is that the asynchronous circuit depends on propagation delay to hold the present-state value.

equals the longest propagation delay (t_{pd}) that can occur in the real combinatorial logic block.

When the circuit is stable (defined as having variables that remain the same for a period equal to or longer than t_{pd}), the present- and next-state variables have the same values. Sometimes, however, the state variables take on several intermediate values before the present- and next-state variables reach stable state. These intermediate values represent unstable states, whereby the output variable values keep changing for a given combination of input values. In extreme cases, the circuit oscillates.

Because the various signal paths through the circuit have different propagation delays, simultaneous changes of two or more input signals could cause unpredictable state transitions. To avoid uncontrolled behavior, therefore, a design should allow only one input variable to change at a time. Further, the time interval between consecutive input-signal changes should be longer than the time necessary to reach a stable state. When these restrictions are enforced, the circuit operates in "fundamental mode."

It's possible that a circuit implementation can allow two or more state variables to change concurrently as a result of input-signal transitions. Such circuits possess race conditions, with circuit behavior depending on which state variable changes fastest. If, after several temporary state transitions the stable state the circuit achieves is the same, no matter which state variable is faster, the circuit has noncritical races. If the final states differ, the circuit has critical races. A good design must operate in the fundamental mode and avoid critical-race conditions.

Latches hold present-state values

In synchronous-state machines, a flip-flop is the memory element that holds the present-state value. In asynchronous-state machines, the memory unit is the latch; **Fig 2a** shows such a latch circuit. The product term (A&B) is called the START term. When this term is true, output Z is true. The product term (B&Z), in which one of the input variables is the feedback from the output, is called the HOLD term. Once START is true longer than t_{pd}, output Z remains set for as long as the HOLD term remains true.

Fig 2b illustrates a model of the asynchronous latch. Assume the primitive gates to have zero delay and that the output of the combinatorial circuit (Z′) is the next-state variable. Output Z takes the value Z′ after a time equal to the propagation delay (t_{pd}) through the circuit. The next-state variable Z′ can be expressed as a Boolean equation: $Z'(t)=A\&B+B\&Z(t)$. The output Z (present-state variable) is $Z(t+t_{pd})=Z'(t)$. Except for the block delay, this circuit model can be analyzed as combinatorial logic; therefore, you can study its behavior using a Karnaugh map type called the transition map. **Fig 2c** shows the transition map for the latch model.

Each column of the transition map represents a combination of the external input variables, and each row represents a combination of the present-state variables. The combinations are arranged so that adjacent rows or columns differ by a change in only one variable. The squares defined by the rows and columns contain the corresponding next-state values (Z′) for the circuit. In **Fig 2**, because A and B are the external input variables and Z is the only present-state variable, all you need to determine the behavior of this latch is a map of four columns and two rows.

This map contains a number of reference marks that aid in understanding the corresponding circuit's behavior. Underneath each input-variable name lies a horizontal bar that covers those squares for which the variable is true. Squares have numbers in their corners for convenient reference. The angled arrows between columns on top of the map indicate the level transitions of Z—if any—due to input transitions.

If you define the circuit's total state as the current combination of input and present-state variables, each square of the transition map has a unique correspondence with a total state of the circuit. Moving from square to square within the map corresponds to changes in the circuit's total state. When the circuit reaches a square whose next-state value coincides with its respective row value, the circuit has reached a stable state. The transition map shows all stable states circled. The remaining squares represent unstable states.

Transition maps track circuit changes

At this point, note that the state of an asynchronous circuit changes almost immediately after an external input changes, instead of following the edge of a clock as in a synchronous circuit. When analyzing the behavior of an asyn-

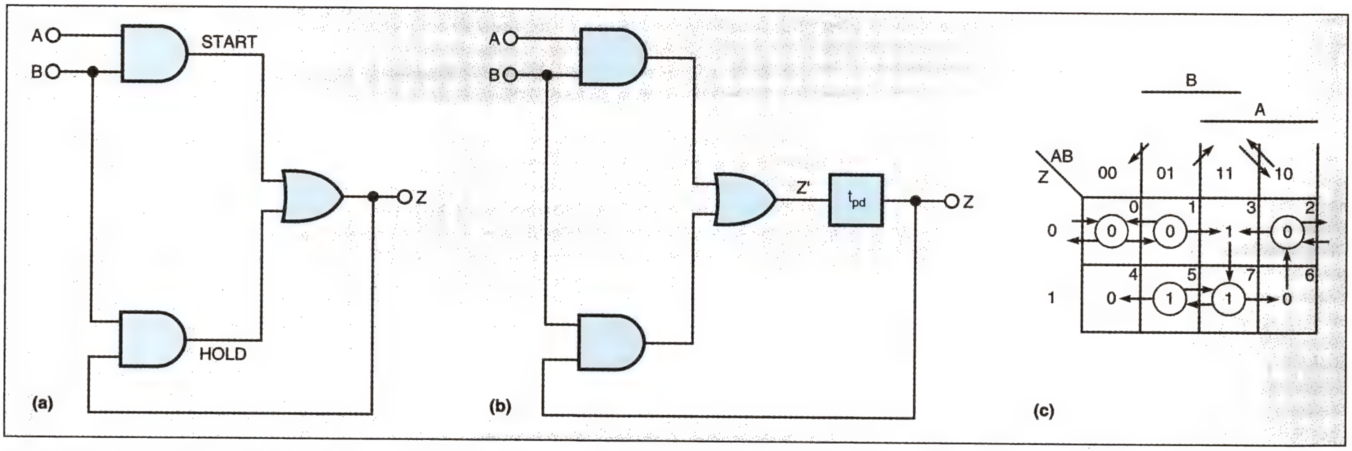

Fig 2—The latch circuit (a) is the memory element of the asynchronous state machine. The asynchronous model (b) and transition map (c) for the latch provide insight into the circuit's behavior.

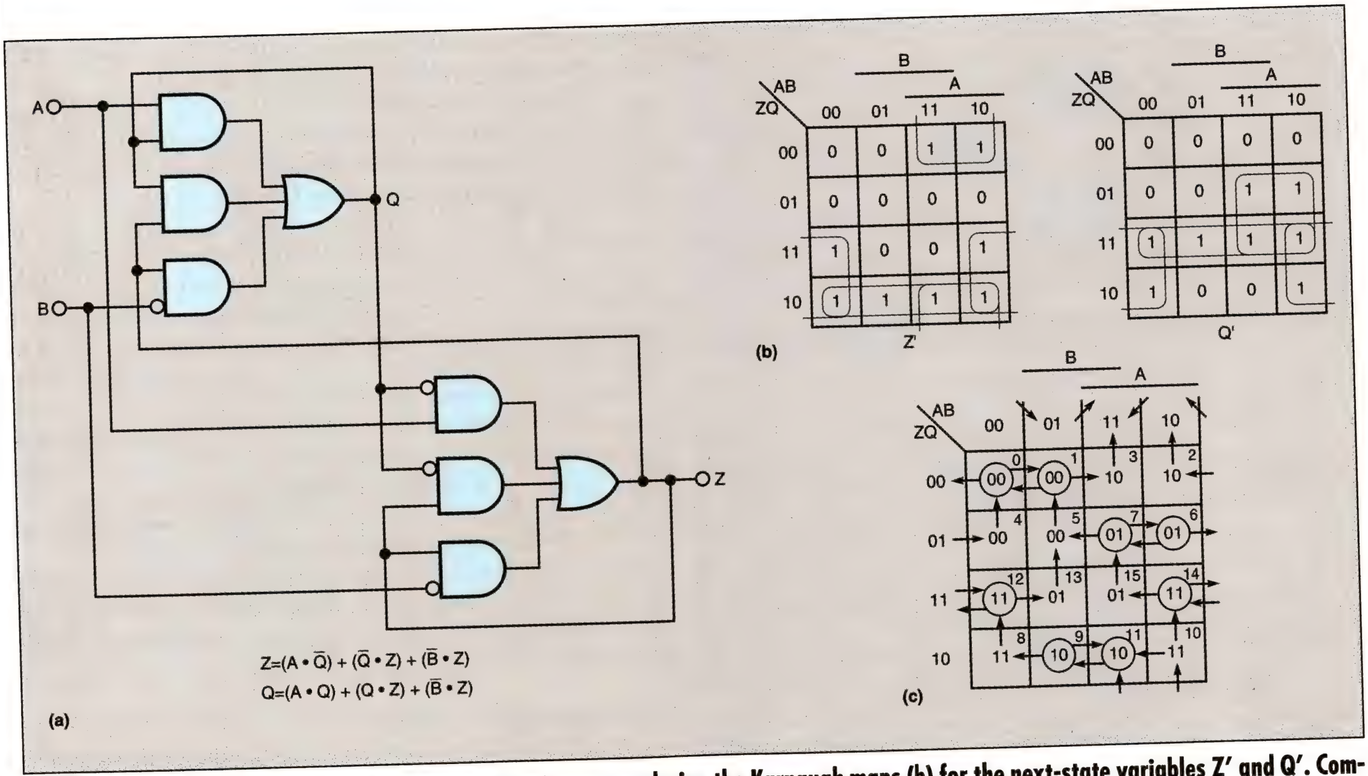

Fig 3—From the logic diagram (a) of this sample circuit, you can derive the Karnaugh maps (b) for the next-state variables Z′ and Q′. Combining these maps yields the circuit's transition map (c).

chronous circuit using transition maps, remember that when an input variable changes, the circuit's state change corresponds to an immediate horizontal transition to the column representing the new input combination. If the new value of the next-state Z' coincides with present-state Z, the new state is stable. Otherwise, vertical transitions subsequently occur until the circuit reaches a state for which Z′=Z.

Analyze the map in **Fig 2c**, which illustrates this behavior. Assume that the input- and output-variable values are AB=00 and Z=0, respectively; then, square 0 represents the circuit's state and gives the next-state value, Z′=0. Because Z′ and Z are the same, the output remains stable. If B changes to "1," the present state is still "0," although square 1 represents the total state. If A now changes to "1," the next-state Z′ becomes "1" and no longer equals Z. The circuit state moves to square 3. This state is unstable, forcing the latch present state to move vertically to the stable state at square 7, because AB remains "11." In a similar fashion, analyze the next state of the latch each time the input values change.

The analysis also applies to circuits with more than one state-memory element. **Fig 3a** shows a logic diagram, for which you can deduce by inspecting the corresponding Boolean equations and Karnaugh maps in **Fig 3b**. The transition map, **Fig 3c**, is a combination of the two Karnaugh maps, formed by concatenating the corresponding values of Z′ and Q′. The values on top of the map represent the present values of the circuit-input variables A and B. The values to the left of the map represent the present-state values (ZQ) of the circuit. The stable states, the squares with next-state values that coincide with the corresponding row values, are circled.

Assume that the system starts in the state corresponding to square 1 (ABZQ=0100). If A then changes to "1," the total

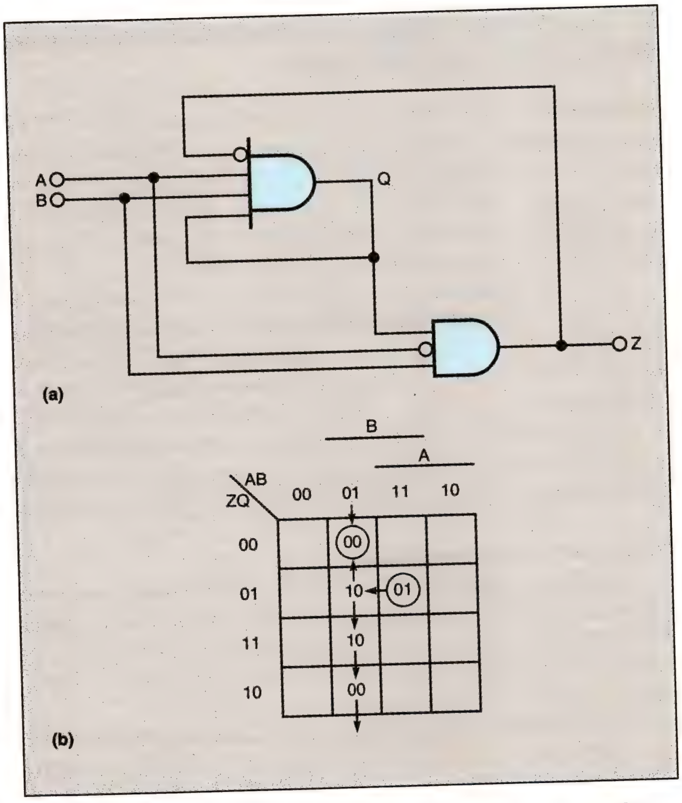

Fig 4—Case 1: This circuit (a) contains a noncritical race condition. If the circuit powers up in the stable-state ABZQ=1101, it responds in two ways to a negative transition in A. As the transition map (b) shows, both responses attain the same end state. The time required to settle, however, varies with the path.

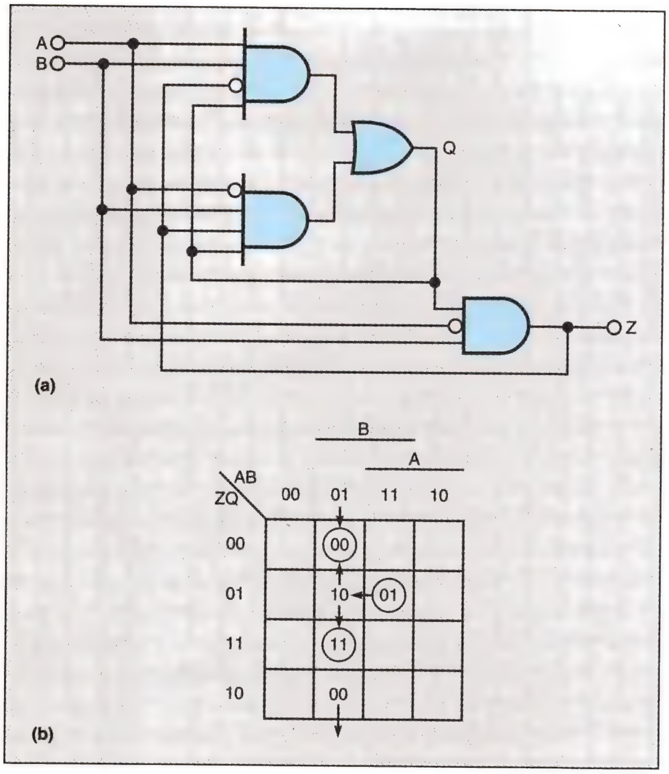

Fig 5—Case 2: The circuit in (a) contains a critical-race condition. As the transition map (b) shows, the circuit can settle in one of two stable states following a change in A. The state the circuit attains depends on which logic block is faster.

state moves to square 3, which shows a next state of "10." The state at square 3 is unstable because ZQ and Z′Q′ are different. The circuit state, therefore, moves to square 11, where the next state is "10." This is a stable state (ABZQ=1110) because the present and next states are the same. The circuit stays in this stable state (ABZQ=1110).

If B then changes to "0," the system moves to square 10, showing a next state of "11." Because this state is unstable, the system state moves to the stable state (ABZQ=1011) at square 14. Similarly, you can continue analyzing the rest of the transition map. Refer to **Fig 3c** for all possible transitions.

For this circuit, each time A sets, Z sets, and when B sets, Z resets. This behavior describes the characteristic of a set/reset flip-flop, whose output depends on the input edge transitions.

Maps chart race conditions

Transition maps provide a valuable tool for analyzing race conditions, which occur when two or more next states change concurrently as the result of an input-value transition. The following examples help illustrate the usefulness of transition maps as an analysis tool:

Case 1: In **Fig 4a**'s circuit, assume an initial state (ABZQ=1101). As the transition map (**Fig 4b**) indicates, the present-state variables ZQ and the next-state variables Z′Q′ are "01." If the input-variable A changes to "0" (AB=01), the next-state Z′Q′ becomes 10. Both Z and Q change concurrently, which sets up a race condition. If the path delays for Z and Q are equal, the circuit undergoes the following transition: 01→10→00.

Because the path delays for Z and Q are usually different, however, the transition from 01 to 10 does not occur directly but rather by one of two potential sequences: 01→11→10→00 or 01→00. In this example, the circuit reaches the same stable state "00" either way, which illustrates a noncritical race. The time needed to settle in the final state, however, remains uncertain because it depends on the path delays.

Case 2: In **Fig 5a**'s circuit, assume a starting state of (ABZQ=1101). As the map in this **fig** shows, when A changes to "0," the following sequences are possible: 01→10→00, 01→00, or 01→11. Thus, two different final stable states are possible for the input transition. This is an example of a critical race. Circuit designs with critical races should be avoided because the outcome of the transitions is unpredictable.

Case 3: The logic diagram in **Fig 6a** and transition map (**Fig 6b**) correspond to an unstable circuit. When AB changes from 11 to 01, ZQ transits between the unstable states "01" and "11" indefinitely, ie, the output Z oscillates for as long as AB=01. Avoid this behavior in the map of a stable circuit.

From analyzing these three cases, it's evident that, for proper operation and predictability of the circuit behavior, it's necessary to ensure that only one next-state variable changes for any given input transition.

Use maps to plan designs

Transition maps are useful not only for analyzing asynchronous circuits, but also for synthesizing a design. For example, consider designing a circuit whose output Z follows A's transitions when B is high and remains stable when B is low. The output Z can be either "0" or "1" for any given combination of AB values. The circuit cannot be simple combinatorial logic. It must be sequential because the output value depends on the values of the present inputs and on the previous states. The timing diagram for such a circuit appears in **Fig 7a**.

The first step in designing this circuit is to draw the transition map, assuming that you can implement the circuit with a 2-state-variable state machine. The output Z is one of the present-state variables; Q is the second present-state variable. Because the circuit has two input variables and two present-state variables, the transition map comprises 16 squares (**Fig 7b**). Each square identifies one combination of input and present-state variables.

The arrows above the transition map indicate desired transitions of Z. As shown, Z's changes follow the transitions of A when B is "1;" ie, Z changes from "0" to "1" if Z is not already "1," when AB changes from "01" to "11." Z changes from "1" to "0" if Z is not already "0" when AB changes from "11" to "01." No other input transition causes Z to change.

The second step is to fill in the squares with appropriate values of the next-state variables Z′Q′. Remember that Z' and Q′ are values that Z and Q take, respectively, after the propagation delay through the circuit. Z′ and Q′ are actually fictitious variables that serve as an aid to understanding the circuit's transitional behavior; Z and Q have no physical reality.

Fill out the transition map by following a few rules:

1. Each time an input variable changes, the circuit makes an immediate horizontal transition to the column that identifies the new input combination; ie, a horizontal transition indicates an input change.
2. If the new next-state value coincides with the row value, the circuit has reached a stable state.

Text continued on pg 124

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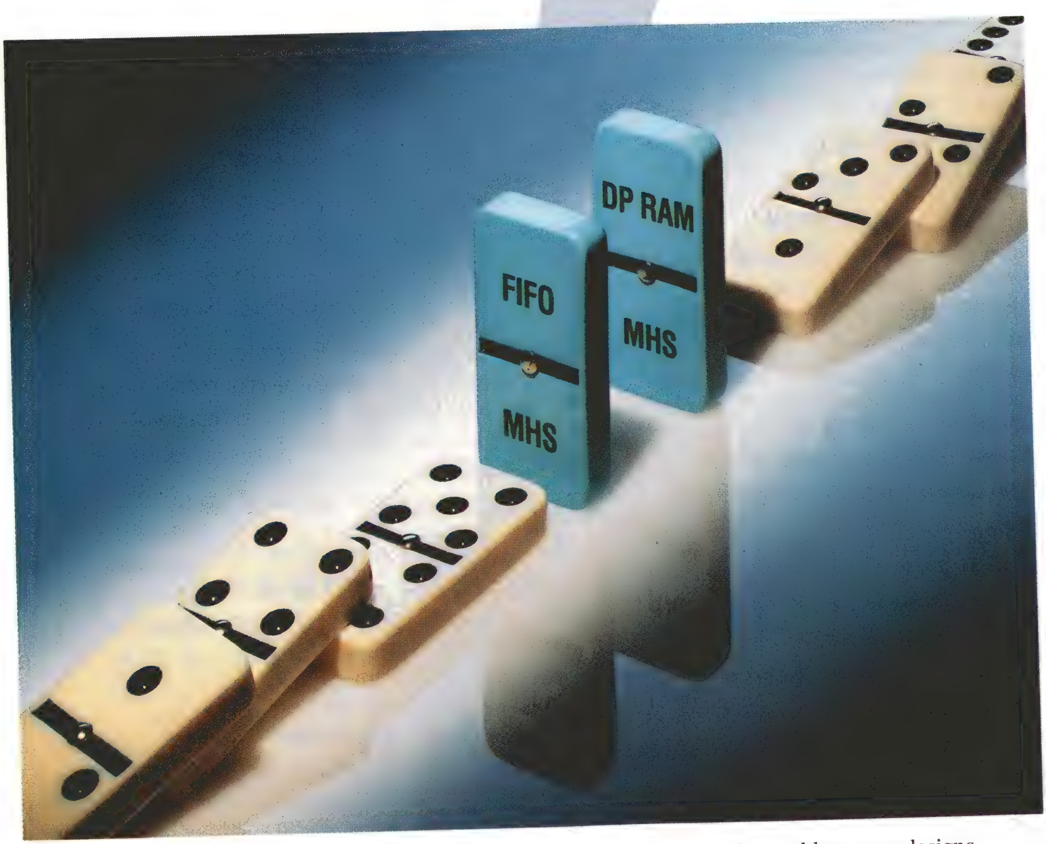

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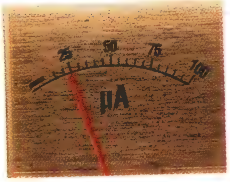

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3. If the new state is not stable, the circuit moves within the same column until the next- and present-state variables are the same. A vertical transition indicates an output change. Each vertical state transition takes one propagation delay, therefore, to maximize circuit performance, your design should have a minimum number of vertical-state transitions before reaching a stable state.
4. To avoid race conditions, only one next-state variable should change as the result of a state transition.

To begin filling in the map (**Fig 7b**), assume that the circuit is in the state that square 5 (ABZQ=0101) indicates and that the system is stable at this location. Because this represents a stable state, the next-state equals the present state, so you can write "01" in the square and draw a circle around it.

If A now changes to "1," Z should also be "1" because B=1. The circuit transits horizontally one square to the right to square 7, where you write "11," showing the change in Z while Q remains the same. In this state, Z′Q′=11 does not match ZQ=01; therefore, the circuit moves vertically (keeping AB=11) to square 15, where ZQ=11. In this square, the circuit reaches a stable state, so you can write "11" and circle it.

If A changes again from "1" to "0," Z should be "0." The new next-state is "01." Now, the circuit transits horizontally to square 13, where you write "01." Because Z′Q′=01 and ZQ=11, this state is unstable. The circuit, therefore, moves vertically to square 5, which was the original stable state (ABZQ=0101).

So far, the circuit meets the requirement, that the value of Z tracks A's transitions while B is true. The remaining requirement is that Z does not change when B is false (B=0). Again, starting at square 5 (**Fig 7c**), when B changes from "1" to "0," the circuit moves horizontally to square 4. The value of Z shouldn't change, but you may want to identify this transition with a new total state. Therefore, toggle the value of Q, and write "00" at square 4. This is an unstable state, so the circuit moves to square 0 (ABZQ=0000), where it will reach a stable state because Z′Q′=ZQ=00. Write "00," and circle it at square 0.

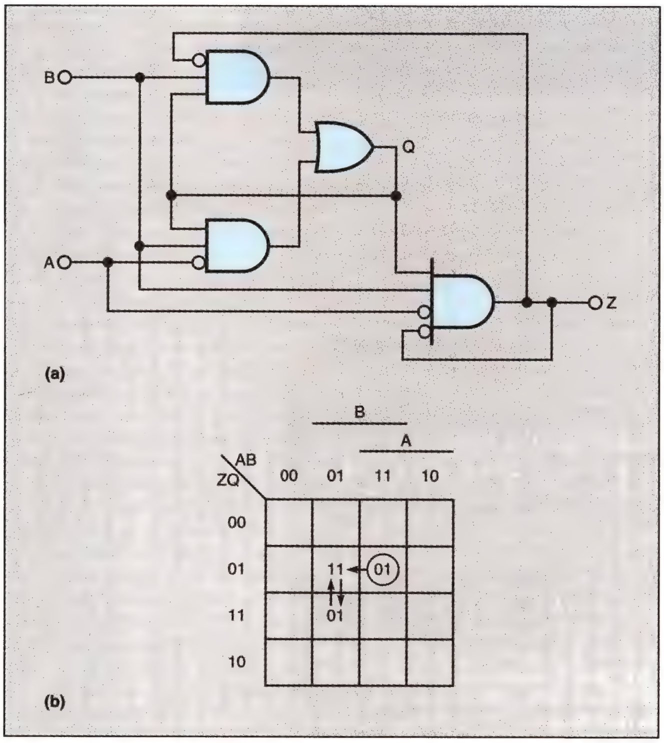

Fig 6—Case 3: This circuit (a) oscillates when the input variables AB change from AB=11 to AB=01. The transition map (b) clearly shows the danger.

Avoid state collisions

If A now changes from "0" to "1," Z should remain "0" because B=0 (remember that Z follows A's changes only when B is high). The circuit moves horizontally to square 2 (ABZQ=1000) where it reaches a stable state. Fill this square with "00," and circle it. If B now changes to "1," the circuit moves to the stable state at square 3 (ABZQ=1100), so you fill this square with "00" and circle it. If A now changes to "0," Z remains "0," and the circuit state moves to square 1.

At this point, assign Q either the value "0" or "1." If you designate Q to be "0," Z′Q′=ZQ=00, and the circuit would reach a stable state at square 1. This state assignment, however, presents a problem: If A subsequently changes from "0" to "1," then Z should move from "0" to "1," which would force square 3 to contain 10 as its next state. Because square 3's next state is already "00," the assignment Q=0 at square 1 causes a state collision.

To avoid the state collision, you must assign Q=1 at square 1 (**Fig 7d**). With "01" at square 1, the state is unstable and the circuit state moves vertically to square 5 (state ABZQ=0101). In a similar way, go through the rest of the states to complete the map (**Fig 7d**).

The example's starting value in square 5 is arbitrary. The state assignments for a given function in a transition map can, therefore, differ, depending on the engineer implementing it. The initial choice does not always work, either. The occurrence of collisions may force you to restart the transition-map state assignment from a different initial stable state. Practice eventually yields an intuitive knowledge of the best state assignment, minimizing the number of transitions before arriving at a stable state and eliminating all potential collisions.

Once you fill out the transition map, the third step in synthesizing a design is to generate the Karnaugh maps from the transition map. The first value of each next-state entry corresponds to the value of Z′; the second corresponds to the value of Q′. **Fig 7e** shows the Karnaugh maps for the example.

Treat don't cares carefully

From these maps, infer the corresponding Boolean equations. When selecting product terms for the equations, take care to avoid a circuit that exhibits output glitches. A rule of thumb for avoiding such hazards is to designate enough product terms to cover all minterms, and add redundant product terms so that adjacent product terms overlap.

Likewise, you need to treat "don't cares" (X) carefully. Assign them values that help simplify product terms. Then, however, take those values back to the transition map, and verify that the assignments do not create potential circuit oscillations such as those *Case 3* indicates.

In **Fig 7d**, square 6 has a don't care next state. The Boolean equations in **Fig 7e** assume that Z′=1 and Q′=1 in square 6. If, during power-up, the circuit enters the state correspond-

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CIRCLE NO. 148

ing to square 6 (ABZQ=1001), the next state is "11," and the circuit moves to stable-state ABZQ=1011 (square 14).

The fourth (and last) step in design synthesis is to draw the logic diagrams for Z and Q. As the logic diagram in **Fig 7f** shows, the implementation comprises a 2-level gate circuit. This type of architecture is very convenient for PAL implementations and ASIC applications; it lets you build convenient special-purpose modules with minimum propagation delay. The present-state variable Z is the actual output of the circuit, and Q is an auxiliary variable. Recall that Z′ and Q′ are fictitious variables that represent the next-state values in the asynchronous-circuit model. The present-state variables Z and Q are the only variables that physically exist and that appear in the circuit-logic diagram.

By using more complex and formal procedures, transition-map analysis can handle circuits with three or more external input variables. Such cases go beyond the scope of this article, however, which provides a conceptual understanding of asynchronous circuits. In general, synchronous circuits may be easier to understand and design. When speed is a high priority, however, asynchronous logic is the answer. Transition-map analysis can guide you to a reliable implementation. EDN

Acknowledgment

Thanks to Dung Do for reviewing this article and contributing to the concepts presented in it.

Author's biography

Ricardo Rabinovich works as a computer designer for Ascom Timeplex in Los Angeles. He holds an EE degree from Buenos Aires University and has done graduate work in computers. Rabinovich has worked with both ASIC and RISC CPU design and has extensive experience in designing synchronous and asynchronous logic.

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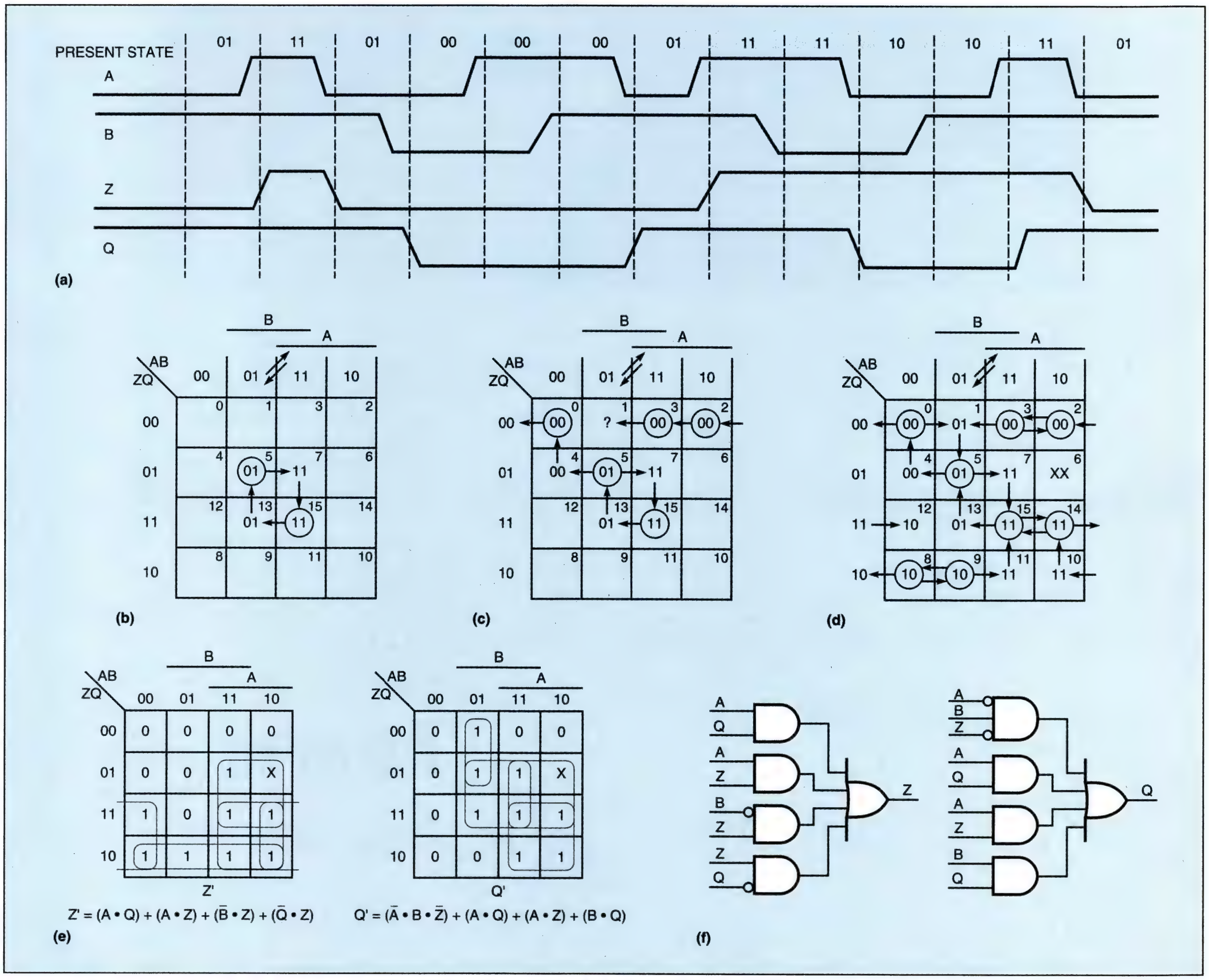
PRESENT STATE
01
11
01
00
00
00
01
11
11
10
10
11
01
A
B
Z
Q
(a)
B
A
AB
ZQ
00
01
11
10
(b)
(c)
(d)
?
XX
Z'
Q'
Z' = (A • Q) + (A • Z) + (B̄ • Z) + (Q̄ • Z)
Q' = (Ā • B • Z̄) + (A • Q) + (A • Z) + (B • Q)
(e)
(f)

Fig 7—The timing diagram (a) for a proposed circuit shows that Z follows A and B=1 and remains stable if B=0. Creating a transition map (b) for the circuit starts at an assumed stable state and fills adjacent squares with the desired next-state values while avoiding state collisions (c). The final state map (d) forms the basis of the Karnaugh maps (e), from which you can derive the final circuit (f).

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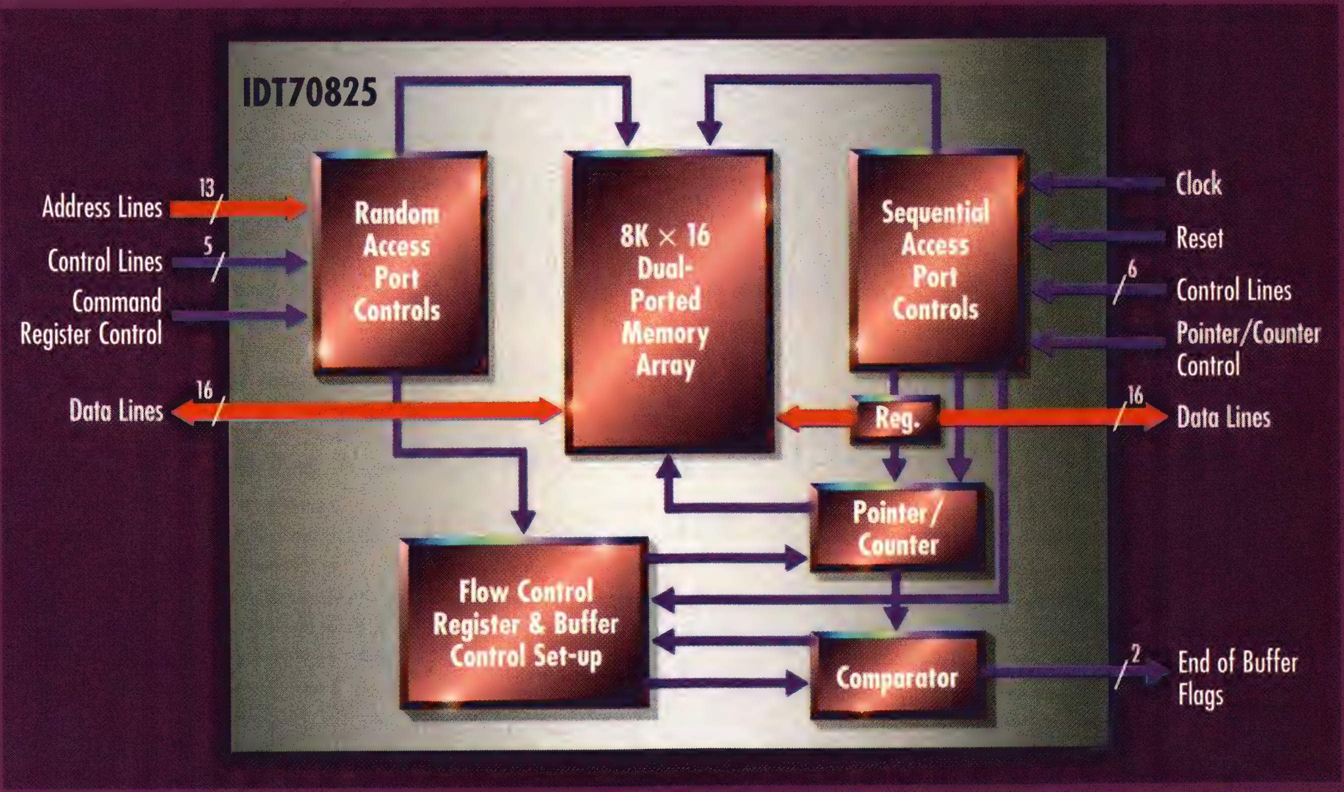

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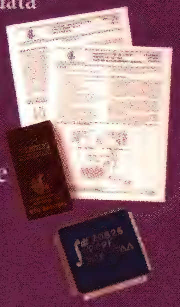

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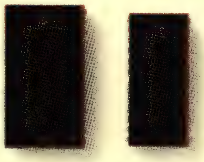

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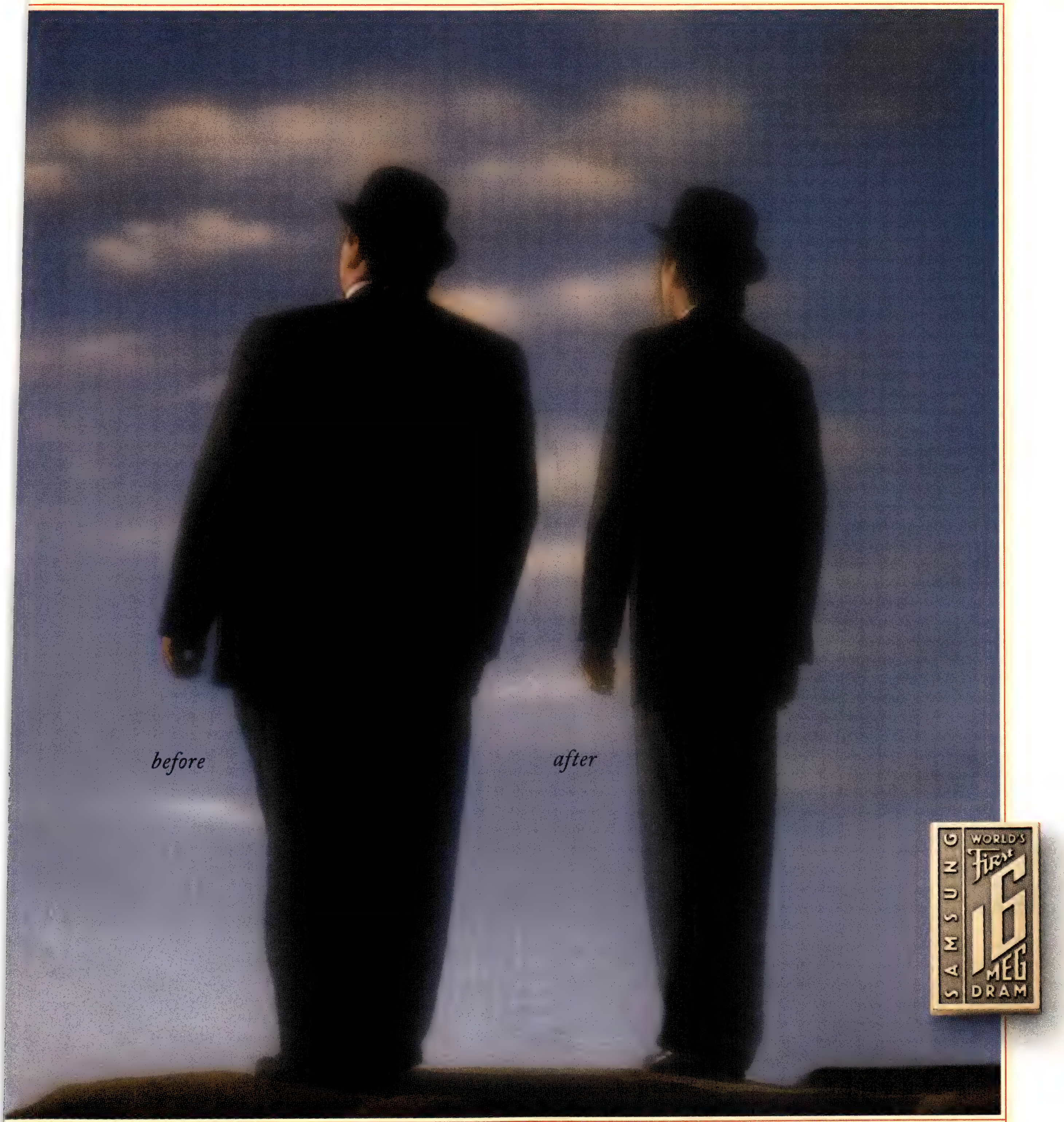

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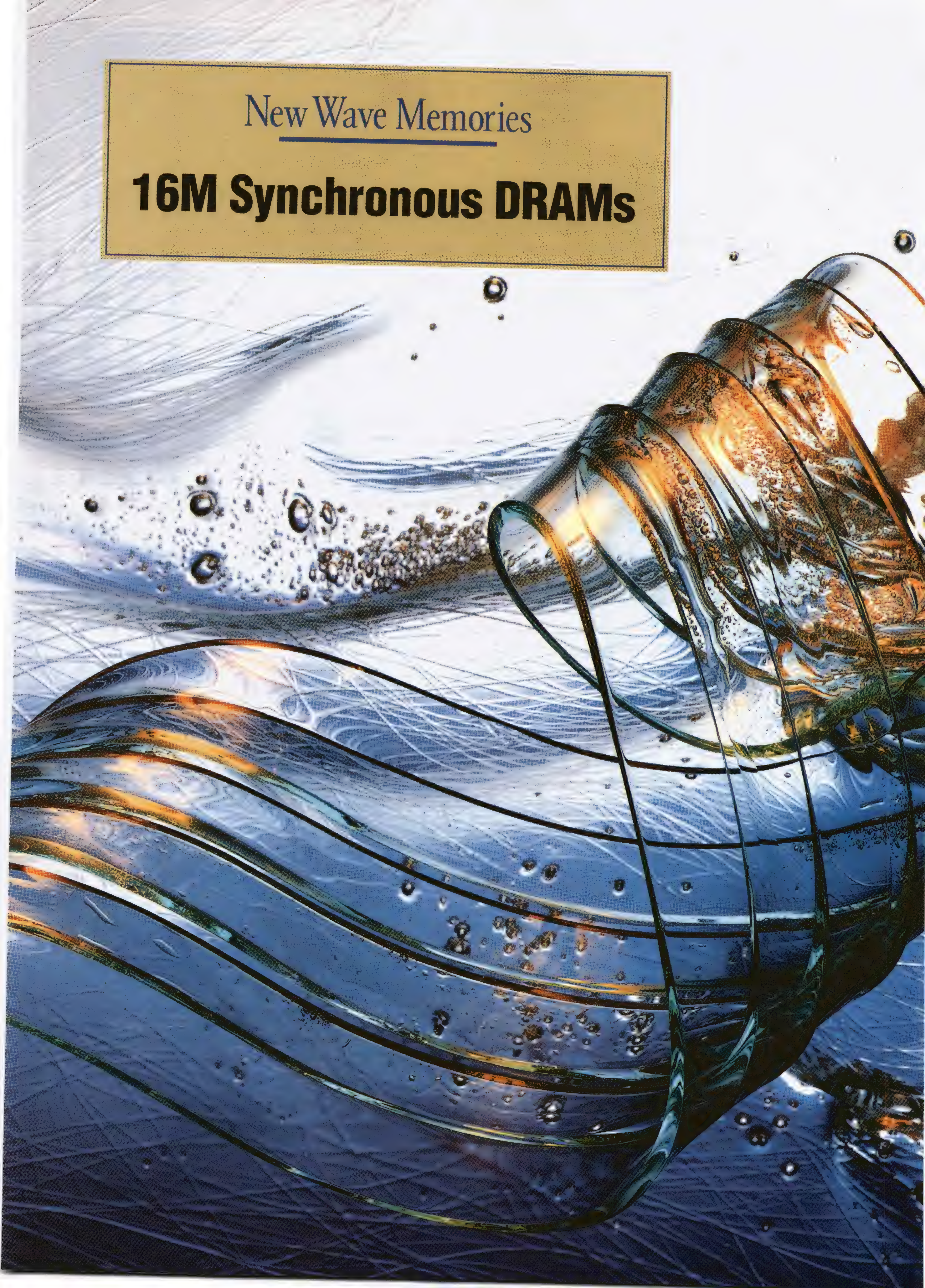

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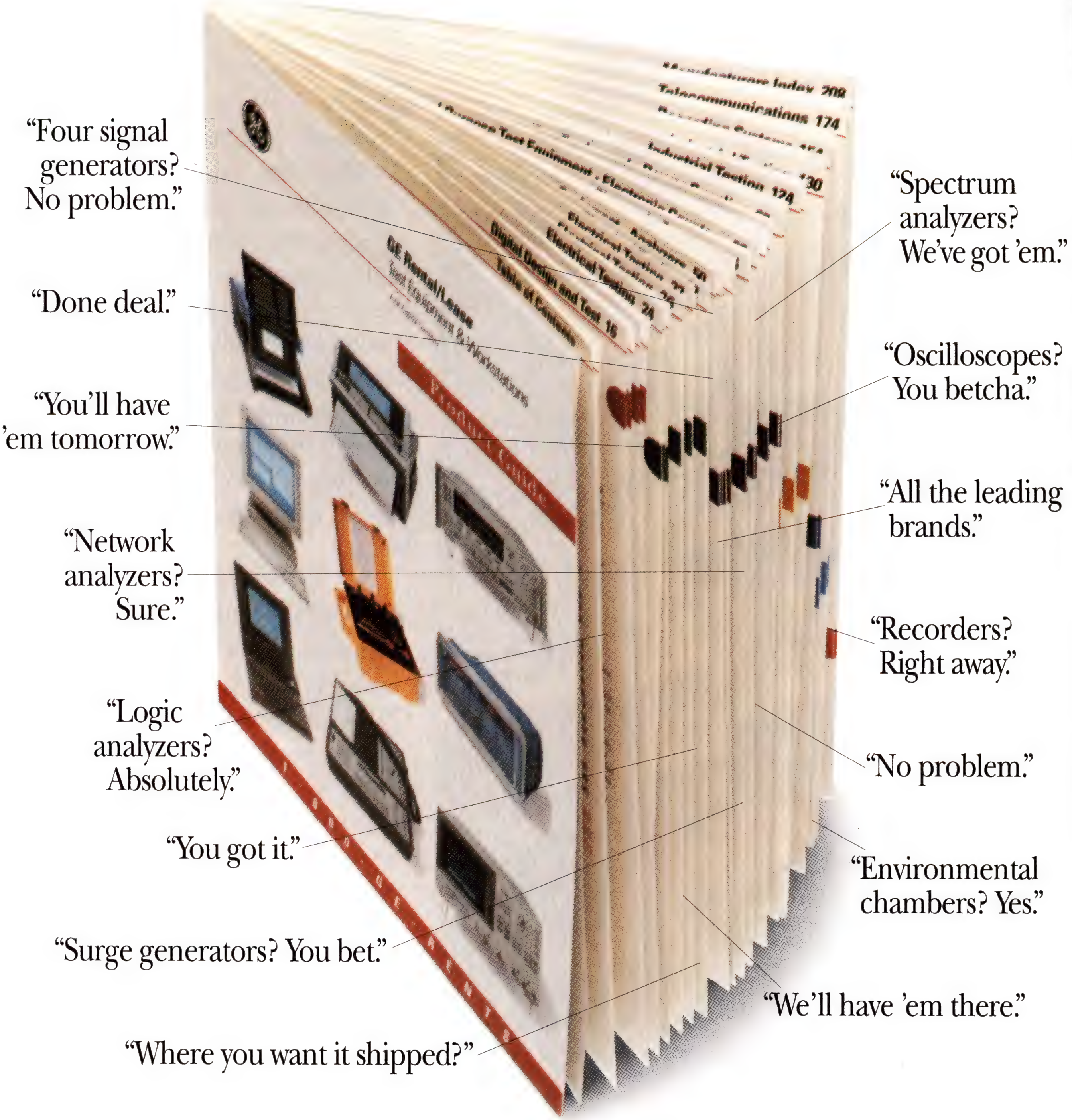
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Test high-speed drivers with bursts and pseudorandom bit patterns

Andreas Pfaff, Hewlett-Packard GmbH

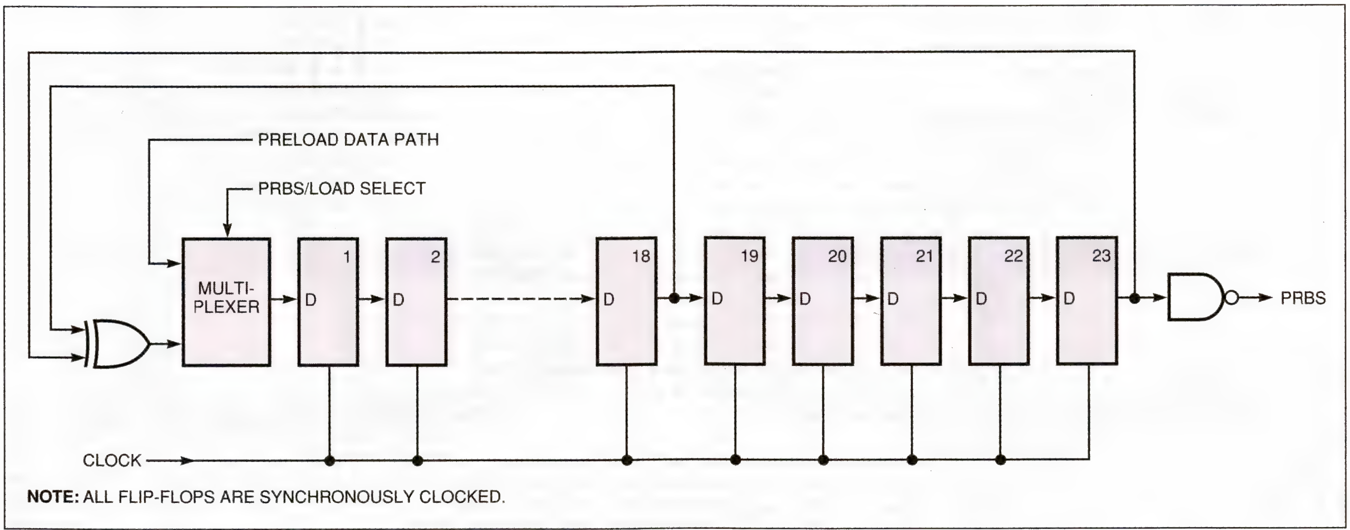
Combine a high-performance, dual-channel pulse generator having burst and pseudorandom bit-stream capabilities with a high-bandwidth sampling oscilloscope for an effective and reliable way to characterize high-speed drivers.

Both manufacturers and users of high-speed drivers need to verify the performance of these devices because performance from part to part varies and depends on the environment in which the driver must work. This environment may be a pc board or a multichip module. Testing high-speed drivers is, therefore, a common application, but the tests present several problems and challenges.

If you verify the performance of a high-speed driver using a cyclic 1010... bit pattern to stimulate it, the part still may not be able to transmit random data streams reliably at the same or even at lower data rates than the test. The reason for this effect is that the behavior of high-speed drivers, especially those fabricated in GaAs, may strongly depend on duty cycle.

For example, if you stimulate an amplifier with a bit pattern that contains many zeros followed by a one, the amplitude at the amplifier's output might be lower and the pulse width of the output pulse might be smaller than you expect. Slow-tail effects, which heavily depend on the semiconductor material and the fabrication process, cause these phenomena.

ICs that contain several drivers may also exhibit crosstalk. Crosstalk occurs between the inputs or the outputs of two adjacent drivers or even between the input of one driver and the output of another. This problem increases as the input signals' transition times decrease.



NOTE: ALL FLIP-FLOPS ARE SYNCHRONOUSLY CLOCKED.

Fig 1—A simple 23-stage shift register and an exclusive-OR gate are all you need to generate pseudorandom bit sequences.

To characterize these effects, you must test drivers with various duty cycles. Using a pseudorandom bit sequence (PRBS) is a good approach because these sequences contain almost all the duty cycles that might occur during data transmissions. In addition, you can also use single-shot burst signals to test drivers. Besides offering the appropriate data capabilities, the signal source that stimulates the device under test (DUT) during these tests should provide ultrafast transitions and the ability to slow these transition times to characterize crosstalk.

What is a PRBS?

The circuit for producing PRBS waveforms according to the CCITT standard No. 0.151 (**Fig 1**) is quite simple. The circuit comprises a 23-stage shift register in which the input of the first D flip-flop connects to the output of an exclusive-OR gate whose inputs connect to the outputs of flip-flops 18 and 23. This circuit automatically generates the PRBS after preloading it with any bit pattern except 000 0000 0000 0000 0000 0000.

This algorithm produces a PRBS comprising all possible 23-bit-long words except "all zeros" and thus produces 2_{23}-1, or 8,388,607, words before the sequence repeats. The PRBS circuit need not necessarily contain 23 flip-flops, but this is the most common standard. Other standards use shift registers comprising seven, 10, 11, or 15 flip-flops. However, more flip-flops generate more word values and thus a more "random" PRBS.

You achieve the best results by using a high-performance pulse generator to stimulate the high-speed driver's input and a sampling oscilloscope to look at its output. A pulse generator, such as an HP 8133A, must have burst and PRBS capabilities and should provide ultrafast transitions. The minimum transition time (TT_{min}) at the driver's outputs determines the minimum bandwidth the oscilloscope requires (BW_{osc}), as the following equation shows:

$$BW_{osc} \geq 10/(3*TT_{min}).$$

So, if the minimum transition time at the output of a driver is about 200 psec, the oscilloscope that characterizes it should have a bandwidth of at least 17 GHz.

Troubleshoot drivers with a PRBS

When analyzing a PRBS pattern with a sampling oscilloscope, the screen shows an "eye diagram" (**Fig 2a**). If the oscilloscope has an infinite-persistence mode, use it to view eye-diagram patterns. Performing eye-diagram measurements is an efficient way to troubleshoot high-speed drivers because the eye diagram can display many problems at once. Eye diagrams show reflections from impedance mismatches, ringing, overshoot, and transition-time problems.

Assuming the DUT is a driver comprising two stages, two other major problems can occur: width variation vs duty cycle (**Fig 2b**) and amplitude variation vs duty cycle (**Fig 2c**). A slow-tail effect in the driver's first stage causes width variation, and a slow-tail effect in the second stage causes amplitude variation. If a pulse does not achieve full amplitude after passing through the driver's first stage, the second stage "sees" a narrower-than-normal pulse because the runt pulse exceeds the input threshold, set to 50% of the expected pulse amplitude, for a shorter time. **Fig 2d** shows the output of the driver when both stages have a slow-tail problem.

Characterizing slow-tail effects

A burst signal is the best way to stimulate a driver if you want to investigate the time constant of a slow-tail effect in the

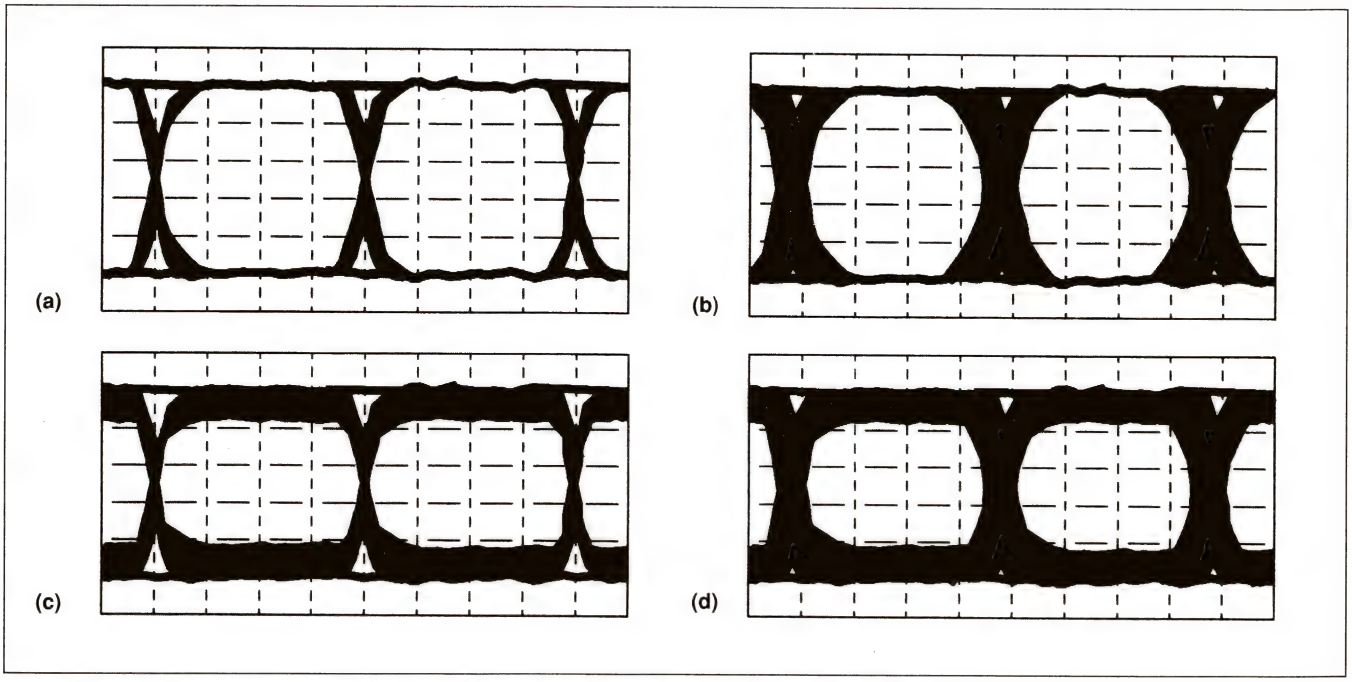


Fig 2—Eye diagrams visibly evidence slow-tail problems in various high-speed driver stages.

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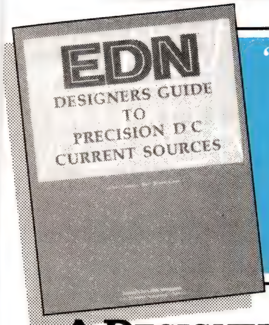

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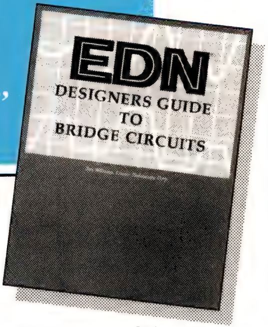

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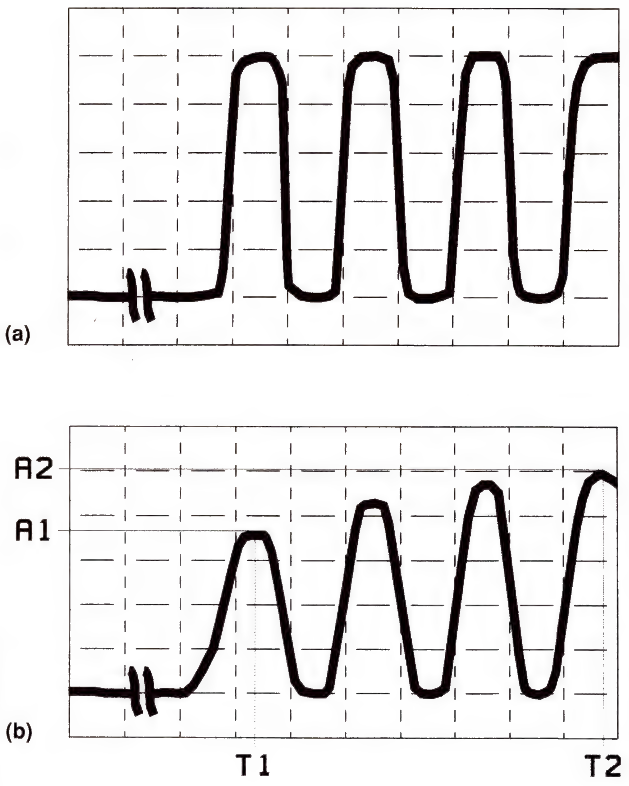


NOTES: TIMEBASE=500 PSEC/DIV
DATA RATE=2 GBIT/SEC
VOLTAGE RANGE=200 mA/DIV
OFFSET VOLTAGE=−1.3V

Fig 3—A burst signal is the best way to stimulate a driver if you want to investigate the time constant of a slow-tail effect in the driver's output stage.

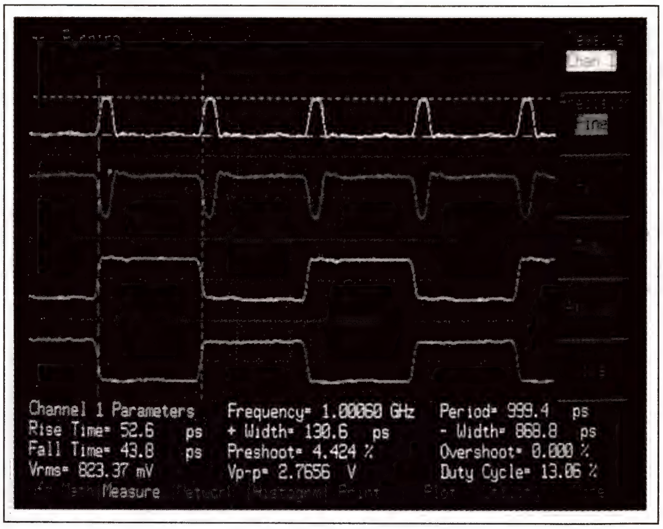
driver's output stage. **Fig 3a** shows the input; **Fig 3b** shows the output signal corresponding to this problem. The following equations calculate the slow-tail time constant of **Fig 3**:

$$A1=A2*exp(-T2-1T1)/T)$$
$$T=(T2-T1)/1n(A2/A1).$$

If the slow-tail effect is not in the driver's output stage but in one of its preamplifier stages, you can measure the effect only if you can bias all the stages that follow the stage with the slow-tail problem to work in the linear mode during the test. Otherwise, instead of the amplitude variation (**Fig 3**), you see only a pulse-width variation, and you cannot determine the slow-tail time constant.

Characterizing crosstalk

A good way to characterize crosstalk between two drivers is to stimulate one with a PRBS and the other with a narrow noise spike (**Fig 4**) or a step function. Vary the delay between these two input signals until you observe the worst-case crosstalk on the oscilloscope's screen. You can also use a bit-error performance analyzer, such as the HP 71603B, to measure the bit-error rate.



```
Channel 1 Parameters   Frequency= 1.00060 GHz  Period= 999.4   ps
Rise Time= 52.6   ps   + Width= 130.6   ps     - Width= 868.8   ps
Fall Time= 43.8   ps   Preshoot= 4.424 %       Overshoot= 0.000 %
Vrms= 823.37 mV        Vp-p= 2.7656  V         Duty Cycle= 13.06 %
```

Fig 4—A good way to characterize crosstalk between two drivers is to stimulate one with a PRBS and the other with a narrow noise spike.

This measurement determines a crosstalk value that depends largely on the transition time of the noise spike or step function. If you need to characterize this dependency, use the pulse generator as the stimulus to provide variable edge rates.

Unfortunately, fast edges and variable edges are more or less mutually exclusive in real pulse generators. Some pulse generators provide electronically variable edge speeds, but the fastest transition time they can generate is typically about 1 nsec. Other instruments—such as the HP 8133A pulse generator—provide ultrafast edge rates that you cannot slow electronically. If you must slow the edges that such instruments generate, add passive lowpass filters, or transition-time converters.

For this application, combining a pulse generator that delivers fixed, ultrafast edges with transition-time converters is a better solution because the fastest transition time you need for testing is about twice the typical input-edge speed presented to the driver during normal operation. Thus, if you expect the typical input transition time to be 200 psec (such as in fast ECL), perform the crosstalk measurement with 100-psec to 1-nsec transition times.

Author's biography

Andreas Pfaff is an R&D engineer at Hewlett-Packard's Instruments Division in Böblingen, Germany. He develops high-speed amplifiers in GaAs and thick-film hybrids. For fun, Pfaff rides a 1969 MotoGuzzi V7.

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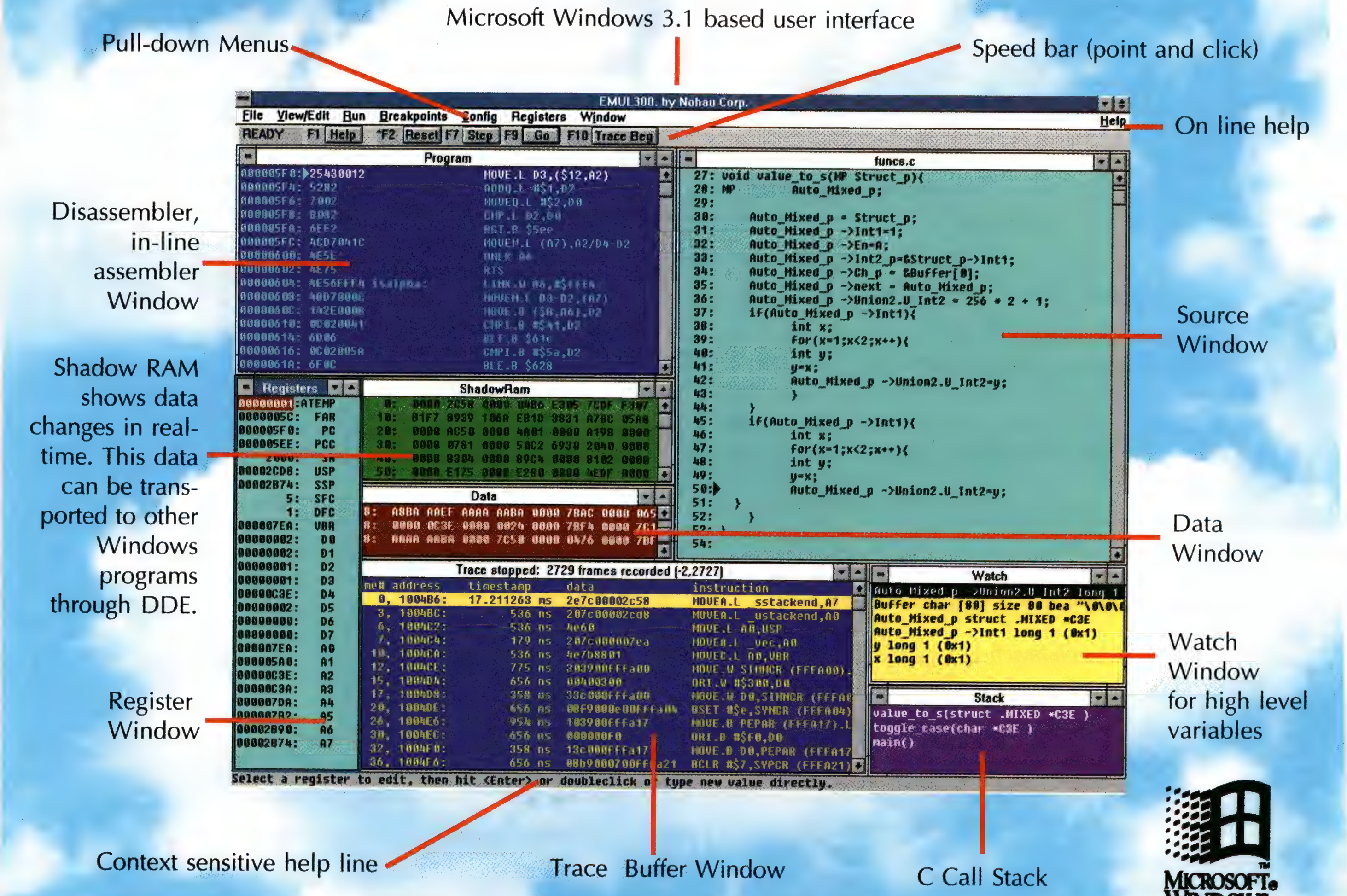
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Registers
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Watch
Stack

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000005F0:▸25430012                 MOVE.L D3,($12,A2)
000005F4: 5282                     ADDQ.L #$1,D2
000005F6: 7002                     MOVEQ.L #$2,D0
000005F8: B082                     CMP.L D2,D0
000005FA: 6EF2                     BGT.B $5ee
000005FC: 4CD7041C                 MOVEM.L (A7),A2/D4-D2
00000600: 4E5E                     UNLK A6
00000602: 4E75                     RTS
00000604: 4E56FFF4 isalpha:        LINK.W A6,#$FFF4
00000608: 48D7000C                 MOVEM.L D3-D2,(A7)
0000060C: 142E0008                 MOVE.B ($8,A6),D2
00000610: 0C020041                 CMPI.B #$41,D2
00000614: 6D06                     BLT.B $61c
00000616: 0C02005A                 CMPI.B #$5a,D2
0000061A: 6F0C                     BLE.B $628
```

```
void value_to_s(MP Struct_p){
MP          Auto_Mixed_p;

    Auto_Mixed_p = Struct_p;
    Auto_Mixed_p ->Int1=1;
    Auto_Mixed_p ->En=A;
    Auto_Mixed_p ->Int2_p=&Struct_p->Int1;
    Auto_Mixed_p ->Ch_p = &Buffer[0];
    Auto_Mixed_p ->next = Auto_Mixed_p;
    Auto_Mixed_p ->Union2.U_Int2 = 256 * 2 + 1;
    if(Auto_Mixed_p ->Int1){
          int x;
          For(x=1;x<2;x++){
          int y;
          y=x;
          Auto_Mixed_p ->Union2.U_Int2=y;
          }
    }
    if(Auto_Mixed_p ->Int1){
          int x;
          For(x=1;x<2;x++){
          int y;
          y=x;
▸         Auto_Mixed_p ->Union2.U_Int2=y;
  }
    }
}
```

```
00000001:ATEMP
0000005C:  FAR
000005F0:   PC
000005EE:  PCC
    2000:   SR
00002CD8:  USP
00002B74:  SSP
       5:  SFC
       1:  DFC
000007EA:  VBR
00000002:   D0
00000002:   D1
00000001:   D2
00000001:   D3
00000C3E:   D4
00000002:   D5
00000000:   D6
00000000:   D7
000007EA:   A0
000005A0:   A1
00000C3E:   A2
00000C3A:   A3
000007DA:   A4
000007B2:   A5
00002B90:   A6
00002B74:   A7
```

```
 0:  0000 2C58 0000 04B6 E305 7CDF F907
10:  B1F7 8939 106A EB1D 3831 A7BC 05A8
20:  0000 AC50 0000 4A01 0000 A19B 0000
30:  0000 0781 0000 50C2 6930 2040 0000
40:  0000 8304 0000 89C4 0000 8102 0000
50:  0000 E175 0000 E280 0000 4EDF 0000
```

```
8:  A8BA AAEF AAAA AABA 0000 7BAC 0000 065
8:  0000 0C3E 0000 0024 0000 7BF4 0000 7C1
8:  AAAA AABA 0000 7C50 0000 0476 0000 7BF
```

```
Trace stopped:  2729 frames recorded (-2,2727)
me# address     timestamp       data               instruction
  0, 1004B6:    17.211263 ms    2e7c00002c58       MOVEA.L  _sstackend,A7
  3, 1004BC:          536 ns    207c00002cd8       MOVEA.L  _ustackend,A0
  6, 1004C2:          536 ns    4e60               MOVE.L A0,USP
  7, 1004C4:          179 ns    207c000007ea       MOVEA.L  _vec,A0
 10, 1004CA:          536 ns    4e7b8801           MOVEC.L A0,VBR
 12, 1004CE:          775 ns    303900FFFa00       MOVE.W SIMMCR (FFFA00).
 15, 1004D4:          656 ns    00400300           ORI.W #$300,D0
 17, 1004D8:          358 ns    33c000FFFa00       MOVE.W D0,SIMMCR (FFFA0
 20, 1004DE:          656 ns    08f9000e00FFFa04   BSET #$e,SYNCR (FFFA04)
 26, 1004E6:          954 ns    103900FFFa17       MOVE.B PEPAR (FFFA17).L
 30, 1004EC:          656 ns    000000F0           ORI.B #$F0,D0
 32, 1004F0:          358 ns    13c000FFFa17       MOVE.B D0,PEPAR (FFFA17
 36, 1004F6:          656 ns    08b9000700FFFa21   BCLR #$7,SYPCR (FFFA21)
```

```
Auto_Mixed_p ->Union2.U_Int2 long 1
Buffer char [80] size 80 bea "\0\0\
Auto_Mixed_p struct .MIXED *C3E
Auto_Mixed_p ->Int1 long 1 (0x1)
y long 1 (0x1)
x long 1 (0x1)
```

```
value_to_s(struct .MIXED *C3E )
toggle_case(char *C3E )
main()
```

```
Select a register to edit, then hit <Enter> or doubleclick or type new value directly.
```

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CIRCLE NO. 186

EMBEDDED SYSTEMS

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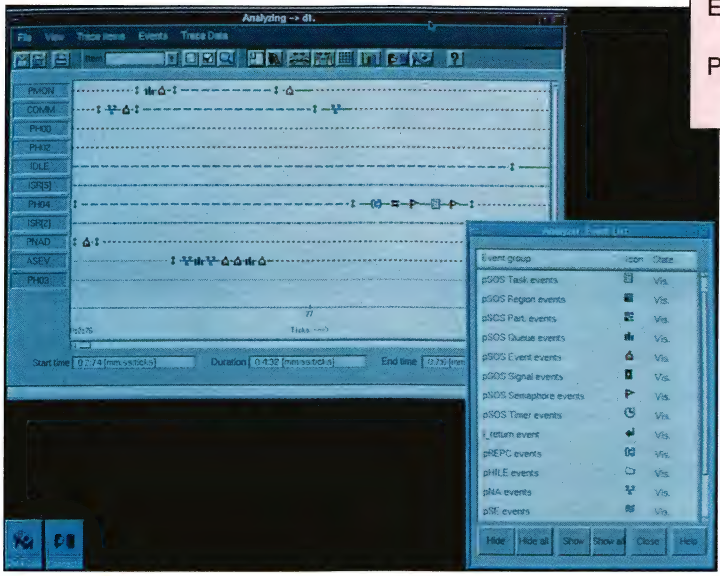
Profiling tool and RTOS look inside your target's operation

The Embedded System profiler (ESp) lets you look at a graphical representation of your target's operation. Instead of trying to debug your real-time multitasking system by looking at the operation of each task individually, you can see how these tasks interact and when events take place via a timeline-based display.

The ESp agent works on the target with either the pSOS+ real-time operating system (RTOS) or the pSOS+m multiprocessor RTOS. It collects information about your application and then sends the data back to the host over a network or serial interface. The ESp host-based analysis software presents the data in a graphical form on the workstation.



You get a visual representation of the operation of your target when using a profiler like ESp.

You can view the target's operation while it is running. It is not necessary to stop it, wait for the data to upload, and then view it. You can also expand and collapse the time scale by panning in and out, slide the horizontal time line to walk through the collected data, and automatically search for the next event. ESp provides μsec-timing resolution and can display data referenced to time or ticks.

Instead of allowing only a single task per graphical line, ESp lets you group tasks. For example, if you are investigating only four of your tasks, but still want to see how they interact with a group of other tasks, you can view them separately and then group the rest of the tasks in one graphical line.

The graphical display provides a time line where events are represented by icons. These icons represent a variety of target events. Clicking on any of the icons brings up screens that display more information about the event.

Event triggering and filtering options let you concentrate on what you want to look at without having to gather and transfer all target operations. A wraparound option lets a system in the field collect data continuously into a circular buffer. Then, if a failure occurs, you can go to the field (or collect the data via modem and phone) and see what happened before the failure.

The tool also assists you in finding stack overflows, those insidious bugs that are often hard to find. This type of error is often not consistent since the stack doesn't always overflow in the same section of code. The tool lets you view stack usage and detect error conditions in real time.

The software doesn't require a lot of target memory to run. It works with the minimum pSOS+ kernel size of 12 kbytes plus 2 kbytes for the ESp agent. It piggybacks on pSOS+ or pSOS+m, letting it work in single or multiprocessing environments. Prices start at $4995. The initial release runs on Sun workstations and Motorola 68000-based targets.—**David Shear**

Integrated Systems Inc, Santa Clara, CA. (408) 980-1500. **Circle No. 393**

In-circuit emulator assists the embedding of the 386

The expected popularity of the Intel 386EX, 386CX, and 386SX for embedded applications is spawning tools to get the job done. The PowerPack-386EX in-circuit emulator (ICE) uses bond-out technology to provide visibility to the internal workings of the μP. Bond-out technology provides a view of the target unavailable from other sources. The emulator pod is small and automatically configures itself for 3.3 or 5V target supply voltage.

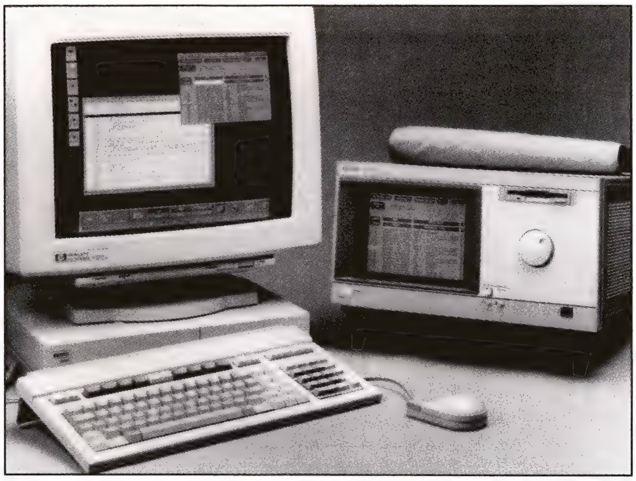
A 128k-word trace buffer (optionally, 256k words) records 96 channels of data. Complex triggering includes sequential combinations of events. Events can be a range of data, address, and signal values. The trace buffer can be partitioned into as many as 256 logical trace buffers, each triggered separately. Trace data is accessible without stopping emulation.

The PowerViews user interface runs under Microsoft Windows 3.1. It provides control of the ICE and offers debugging features, such as a variable window, a stack browser, multiple memory windows, and C source-level debugging. The ICE supports Borland, Microsoft, Metaware, MRI, and Watcom compilers and other tools that create OMF86 and OMF386 symbol tables.

The PowerPack-386EX is based on the PowerPack line of ICEs. This ICE line works with μPs running up to 40 MHz, faster than the currently available 25-MHz 386 μPs. The 1 or 4 Mbytes of overlay memory runs without wait states. Prices start at $19,500.—**David Shear**

Microtek International Inc, Hillsboro, OR. (503) 654-7333. **Circle No. 394**

Step through trace buffer in high-level source code



The real-time trace data that the logic analyzer gathers is referenced to your source code, letting you step through the trace in your high-level source code.

Logic analyzers have long been able to acquire a trace of the execution of a target µP. Disassemblers then became available to present the acquired trace data in mnemonic form. Lately, the symbol tables from your source code could be loaded into the logic analyzer to aid your understanding of the disassembled code.

Now, the HP B3740A software analyzer, an add-on product for the HP 16500B logic analyzer, presents the real-time trace in the high-level source code. No longer must you manually translate the data within the logic analyzer's source buffer into its source-code equivalent.

Three windows let you control and view the trace buffer's data. The control window accepts input-measurement requests, such as defining a trigger, and displays µP mnemonics. The acquired trace is also displayed in the source window as high-level source code. The trace-list control window lets you single-step through the captured trace.

The data in the source and control windows are interlocked. You get a time-correlated view of your program's execution in both high-level source and µP mnemonics. You can step through the captured trace by source line or by the state of the µP's bus.

The software analyzer automatically accepts symbolic information if your language generates IEEE-695 or Intel OMF86, OMF286, or OMF386 symbol formats. A generic ASCII format is also available for other symbol formats. The software analyzer runs on Windows-based PCs, Sun SPARC workstations, and HP series 700 workstations. $1400.—**David Shear**

Hewlett-Packard, Palo Alto, CA. (800) 447-3282. **Circle No. 395**

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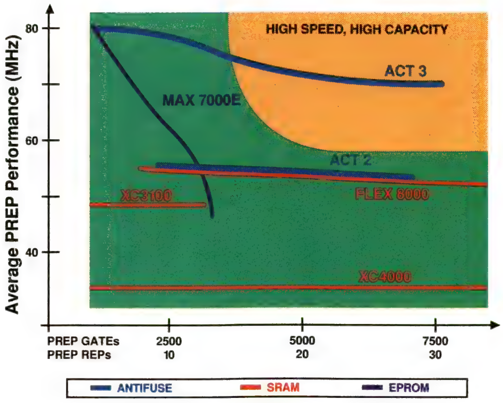

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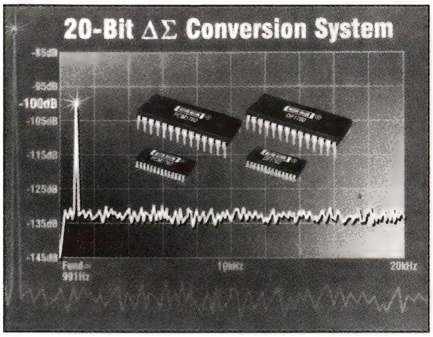
INTEGRATED CIRCUITS

12-bit ADC runs on 3.3V. The HI5813 consumes a maximum of 9 mW over the industrial temperature range and at its full sampling rate of 40k samples/sec. The ADC's analog-input bandwidth is 1 MHz, and the total unadjusted error of the industrial version is 9 LSB. Differential linearity is 2 LSB. The device is available in 24-pin DIPs and SOICs. The DIP industrial and commercial versions cost $10.45 and $9.50 (100), respectively. **Harris Semiconductor**, Melbourne, FL. (800) 442-7747. **Circle No. 422**

Peripherals support HC11 processors. The X68C75 and X88C75 EEPROMs are designed for use with HC11 microcontrollers. The devices have 16 bytes of SRAM, two 8-bit I/O ports, internal-address decoding, and 8 kbytes of EEPROM. The EEPROM array can be read while completing a write operation and is available preprogrammed with your data. $8 (10,000). **Xicor Inc**, Milpitas, CA. (408) 432-8888. **Circle No. 423**

Current-mode PWM IC controls primary side. The UC3848 PWM IC allows accurate primary-side control of secondary-side current in isolated switching power supplies. A patented current-waveform synthesizer allows the IC to simulate the inductor current during the off-time. By monitoring switch current during on-time and synthesizing inductor current during off-time, the IC provides a complete inductor-current waveform without the need for secondary-side measurements. The IC features a low peak-to-average current ratio and a start-up current of 500 µA. $4.08 (1000). **Unitrode Integrated Circuits Corp**, Merrimack, NH. (603) 424-2410. **Circle No. 424**



Audio ADC system delivers 108-dB dynamic range. The PCM1760 ADC and DF1760 digital filter provide 20-bit resolution, –92-dB THD plus noise, and 100-dB S/N ratio. The delta-sigma conversion system uses proprietary multibit noise-shaping circuitry to achieve the wide dynamic range with lower noise than single-bit designs can achieve. The system samples in the 30- to 50-kHz range. Channel separation is 94 dB min and 98 dB typ. The filter's stopband attenuation is 100 dB, and passband ripple is 0.001 dB. The ADC and filter cost $14.37 and $15.52 (1000), respectively. **Burr-Brown Corp**, Tucson, AZ. (800) 548-6132. **Circle No. 425**

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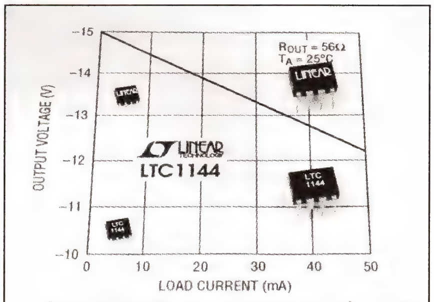
Clock generators have as many as eight outputs. A family of low-jitter, dual-VCO clock generators works on motherboards with X86, Pentium, or RISC µPs. The W48C54 has five outputs, and the W48C55 has eight outputs. The devices provide selectable and fixed-frequency clocks, use a single external 14.318-MHz reference crystal, and have output frequencies as high as 100 MHz. W48C54, $3.13; W48C55, $3.23 (1000). **IC Works**, San Jose, CA. (408) 922-0202. **Circle No. 426**

Serial EEPROM supports 64-kbyte/sec read-transfer rate. The X25640 is a 64-kbit serial EEPROM that sustains a random-byte read-transfer rate of 64.4 kbytes/sec. A serial peripheral interface supports clocking speeds as high as 2 MHz. The device has an 8k×8-bit configuration and includes data-protection features. The device's interface connects directly to the serial port of most µCs. Device in a DIP; $3.50 (10,000). **Xicor Inc**, Milpitas, CA. (408) 432-8888. **Circle No. 427**

ESD-protection array protects against 15-kV transients. An SCR-based ESD/overvoltage-protection array protects as many as six lines from 15-kV discharges. The SP721 switches in <6 nsec and handles 2A of peak current. When a voltage on an input pin exceeds one diode drop above the level on the IC's V+ pin or one diode drop below the level on the V– pin, the associated SCR turns on, conducting the transient current to ground through a typical on-resistance of 1Ω. PDIP and SOIC versions cost $0.95 each (1000). **Harris Semiconductor**, Melbourne, FL (800) 442-7747, ext 7204. **Circle No. 428**



Output Voltage vs Load Current, V⁺ = 15V

DC-DC inverter/converter has 2 to 18V input range. The switched-capacitor LTC1144 outputs complementary voltages of –2 to –18V at currents up to 20 mA. A shutdown pin reduces quiescent current to 8 µA. Typical power conversion efficiency is 93%. The IC requires only two external components. An output resistance of 60Ω minimizes conversion losses. An internal oscillator runs at 10 kHz, but you can overdrive it using an external clock or slow it by connecting a capacitor. In 8-pin DIPs and SOICS, the devices cost $2.50 and $2.55 (1000), respectively. **Linear Technology Corp**, Milpitas, CA. (408) 432-1900. **Circle No. 429**

Digital switches suit mixed voice/data/video applications. The 256×256-channel MT8985 enhanced digital nonblocking switch suits PCM-encoded voice and data in digital exchanges and voice-processing systems. A double buffer provides a constant delay through the switch. The MT8986 multiple-rate digital switch operates at higher I/O data rates and switches 4-bit adaptive-differential pulse-code-modulation bit streams. The device handles 4.096 and 8.192 I/O bit streams. MT8985 starts at $11.64 (1000). MT8986 starts at $14.54 (1000). **Mitel Semiconductor**, Kanata, ON, Canada. (613) 592-2122. **Circle No. 430**

Tachometer/speedometer driver provides high accuracy. The CS-8190 driver converts incoming speed-sensor information into an analog output signal that drives the air-core gauge needles in an instrument cluster's speedometer and odometer. The IC's linear output-vs-speed transfer function eliminates the need for skewed artwork on the gauges. A differential output drive provides higher torque and makes heavy gauge needles respond quickly and accurately to direct sensor input. A doubled input-signal frequency reduces needle response time and flutter. For harsh

INTEGRATED CIRCUITS

SHORTS

The DG417, DG418, and DG419 families of switches (starting at $8.16 (100)) comply with MIL-STD-883. They have maximum leakages of 250 pA at 25°C, maximum turn-on and -off times of 175 and 145 nsec, respectively, and maximum on-resistances of 35Ω. The DG406 and DG407 ($22.68 (100)) 16-channel, single-ended and 8-channel, differential multiplexers exhibit on-resistances of 100Ω max. Typical charge injection is 20 pC. **Maxim Integrated Products**, (408) 737-7600. **Circle No. 438**

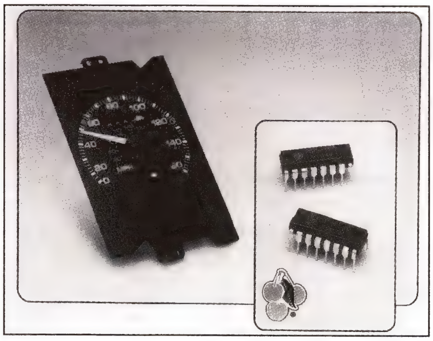
A lower-cost alternative is now available to the 1%-accurate MAX921 through MAX924 comparator/reference ICs. Featuring a 2%-accurate reference, the MAX 931 through MAX934 series is otherwise identical to the previous family, featuring single, dual, and quad micropower comparators. Prices start at $0.98 (10,000). **Maxim Integrated Products**, (408) 737-7600. **Circle No. 439**

The EnGenius on-line database now provides current-to-the-hour information on components, semiconductors, and connectors from such manufacturers as AMD, AMP, Fujitsu, Motorola, and Texas Instruments. Search costs for modem access start at $39/month. **Info Enterprises**, (800) 851-7536. **Circle No. 440**

VLSI Technology has developed the MY008 Data Encryption Standard cell for its cell-based and gate-array ASIC libraries. The cell performs the ECB-mode calculation. **VLSI Technology**, (408) 434-3000. **Circle No. 441**

Synergy Semiconductor is now an authorized alternate source for Motorola's ECLinPS Lite high-speed logic devices. **Synergy Semiconductor**, (408) 730-1313. **Circle No. 442**

Motorola has reduced the price of its 2-chip FDDI chip set, containing the 68840 interface and 68836 clock generator chips, to $59.95 (10,000). **Motorola**, (512) 891-3823. **Circle No. 443**



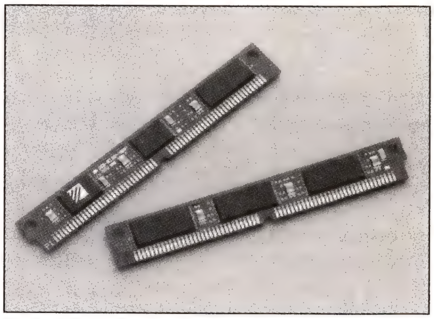
automotive environments, the IC provides load-dump protection to 60V and ESD immunity to 4000V. In a 16-pin DIP and 20-pin SOIC, the IC costs $1.25 (10,000). **Cherry Semiconductor Corp**, East Greenwich, Rhode Island. (800) 272-3601. **Circle No. 431**

Flash memory operates at industrial temperatures. The M5M28F101-151 flash memory operates from –40 to +85°C. The device features a 150-nsec access time and a minimum of 1000 erase/program cycles. The 128k×8-bit device draws a maximum active current of 33 mA and 1 mA in standby mode. Erase/program operations require a 12V power supply, and read mode requires a 5V supply. The device comes in 32-pin TSOPs and plastic leaded chip carriers. $8 (10,000). **Mitsubishi Electronics America Inc**, Sunnyvale, CA (408) 730-5900. **Circle No. 432**

Crosspoint switch operates at 800 Mbps. The TQ8032 32×32 crosspoint IC operates as fast as 800 Mbps/port. The GaAs device suits SONET, Fiber Distributed Data Interface, Fibre Channel, and serial-digital-video applications. The switch is built from the company's source-coupled FET logic standard cells. The symmetrical switching characteristic in the differential ECL-compatible inputs and outputs result in a low skew of ±280 psec and low crosstalk and jitter of 100 psec. $500 (25). **TriQuint Semiconductor**, Beaverton, OR. (503) 644-3535, ext 225. **Circle No. 433**

Chip combines transmitter and mixer. The PMB2206 chip converts a baseband signal into an RF carrier signal for a wireless system using an on-chip transmitter and two local oscillators. An integrated double-balanced Gilbert Cell mixer performs the up-conversion. The chip combines the functions of the company's PMB 2330 Gilbert Cell mixer and PMB 2200 transmit modulator in a single 20-pin, plastic dual small-outline, surface-mount package. $5.25 (10,000). **Siemens Components**, Cupertino, CA. (800) 777-4363, ext 273. **Circle No. 434**

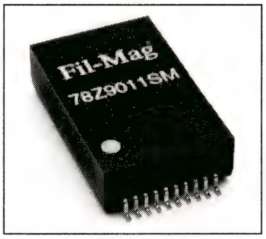
Programmable modem chips target V.34. The DSP163x modem chipset family features onboard memory for DSP code. The memory allows the devices to readily adapt to new modem standards, such as the emerging V.34 28.9-kbps standard. The DSP1633F offers RAM that is downloadable from floppy disk or on-line connections. The DSP1634 is a pin-compatible ROM-based version that will have V.34 code when the specification is final. All chip sets include a DSP chip and a digital-line interface device. The DSP1633F costs $95 (10,000) plus a 1-time object-code license fee. **AT&T Microelectronics**, Allentown, PA. (800) 372-2447. **Circle No. 435**



Module combines SRAM, flash, and EEPROM on one SIMM. The EDI9F3420C combines 128k×8-bit SRAM for data, 128k×8-bit flash memory for programing, and two 32k×8-bit EEPROMs for booting. The 16-bit-wide device interfaces with 16-bit μPs in applications requiring data memory and rewritable nonvolatile memory. A 64-lead SIMM package contains more than 4.5 Mbits of memory. $149 (100). **Electronic Design Inc**, Westborough, MA. (800) 800-7726 **Circle No. 436**

Surface-mount memory module is 35 mm^2. The WS family of 4-Mbit SRAMs has a 128k×32-bit organization. The devices come in 35-mm^2, 5.5-mm-high, surface-mount packages and in 0 to 70, –40 to +85, and –55 to +125°C temperature ranges. Screening to MIL-STD1772 is optional. The modules are constructed on a multilayer ceramic substrate and hermetically sealed with a welded metal cover. $260 (100). **White Technology Inc**, Phoenix, AZ. (602) 437-1520. **Circle No. 437**

100Base-VG Module for Emerging IEEE 802.12 Standards

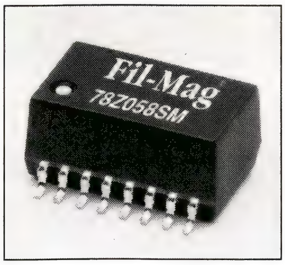


Fil-Mag® sets industry standards by introducing the first, and smallest, functional magnetic and filter module for emerging 802.12 compatible 100Base-VG LAN standards. The 78Z9011SM module is designed for use on four pairs of voice grade Category 3 twisted pair wires with 5B/6B encoded 100 Mbps data transmission rate using a demand priority access method. Its internal common mode chokes can complement design compliance with FCC class B EMI standards. The module is well suited for both network interface cards and hubs. The 20-pin surface mount package is available in tubes and tape and reel.

Fil-Mag®, Tel: (619) 569-6577, Fax: (619) 569-6073.

CIRCLE NO. 221

Magnetics for 100Base-T and TP-PMD



The 78Z058SM magnetic module was developed for both ANSI X3T9.5 (X3T12) TP-PMD and emerging IEEE 802.3u 100Base-T fast ethernet standards. The module is designed to work with transceivers that have an internal low pass filter; for such transceivers, the 78Z058SM provides the required functions of equipment isolation and common mode filtering. The module provides an access to an external terminating resistor at the connector side for additional improvement in EMI performance. This module is ideal for network interface cards and multiport repeater applications.

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CIRCLE NO. 222

SMT Quad Filter Meets IEEE 802.3 Standards for Multiport ICs

Fil-Mag's® fully integrated SMT quad filter targets IEEE 802.3 compatible LAN multiport repeater and hub applications. The 62-pin, low profile device incorporates four transmit and four receive channels and features low pass filtering, equipment isolation, impedance matching, and EMI filtering to offer a complete analog solution for high data integrity.

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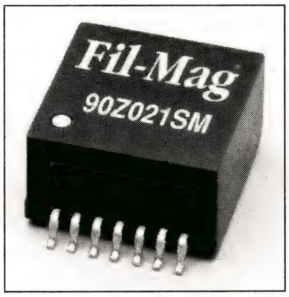
CIRCLE NO. 223

DC/DC Converter Magnetics Available to OEMs for Hybrid Designs



Industry proven DC/DC converter magnetic components, the 90Z Series, are now available to OEMs designing and building their own converters. DC/DC converter design schematics and complementary component lists using the 90Z Series parts are on readily available data sheets. 90Z Series components accommodate 5 or 12 volt designs, regulated or unregulated, with or without enable, and the polarity may be TTL high or low. A full line of complete DC/DC converters is also available.

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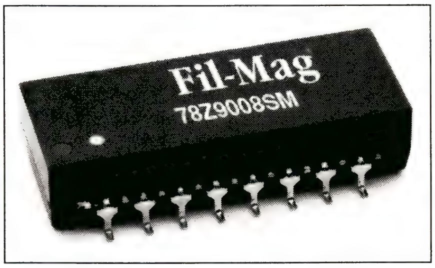
CIRCLE NO. 224



FDDI Module Meets X3T9.5 (X3T12) TP-PMD Standards

Fil-Mag's® new 78Z9007, 78Z9008SM, and 78Z9009SM provide a complete analog solution between FDDI transceivers and Category 5 UTP cable per proposed standards set by the TP-PMD, ANSI X3T9.5 (X3T12) TP-PMD committee. The 16-pin SMT modules include transmit and receive channels and operate with MLT-3 encoded data, where operations over a wide bandwidth and fast risetimes are critical system requirements. Crosstalk is significantly reduced to improve signal-to-noise ratio.

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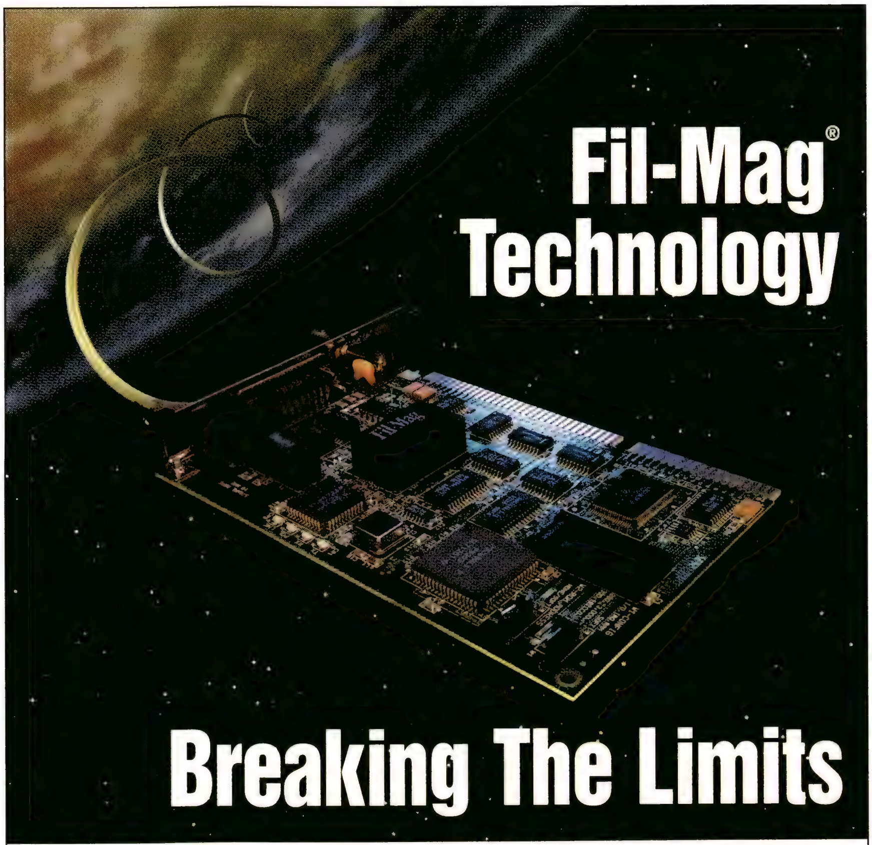
CIRCLE NO. 225



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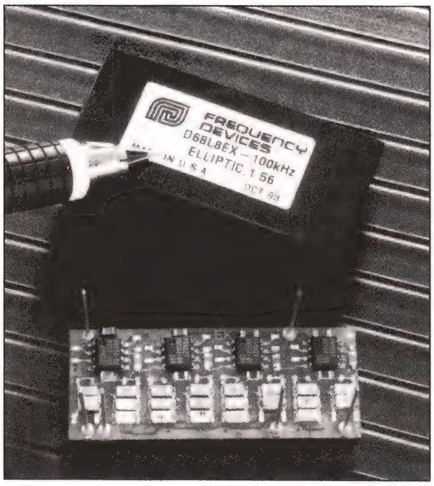
Macrocell handles J1850 protocol. The J1850 protocol converter, part of the vendor's ASIC macrocell library, is the Society of Automotive Engineers' standard for in-vehicle multiplexing systems. The converter sequences messages across the bus, removing that burden from other data-communication devices. The converter uses internal RAM to buffer messages to and from the serial-data bus. Prices vary with system needs. **NCR Microelectronic Products**, Detroit, MI. (800) 334-5454.
Circle No. 444

Bus transceivers offer third port. The SN74ABT32316PN and SN-74ABT32318PN are 16- and 18-bit universal bus transceivers with three bidirectional ports. They can operate in flow-through, latched, clocked, and clock-enabled modes and have a propagation delay of 6.5 nsec. The devices include bus-hold cells to eliminate the need for pull-up resistors on unused input lines and offer a 64-mA drive current. The devices come in an 80-pin TQFP and cost $10.95 (1000). **Texas Instruments Inc**, Denver, CO. (800) 477-8924, ext 4500. **Circle No. 445**



Elliptic filter simplifies time- and frequency-domain conversions. The D68EX 32-pin DIP linear-active filter exhibits a Cauer-elliptic transfer function with 80 dB of attenuation at 1.56× the cutoff frequency, F_C. The filter permits sampling at 2.56 F_D, simplifying time-/frequency-domain calculations. Lowpass and highpass versions are available from 10 to 100 kHz. $151 (1), $120 (1000). **Frequency Devices Inc**, Haverhill, MA. (508) 374-0761.
Circle No. 446

UHF receiver IC cuts power needs. The U431XB UHF receiver has a standby current of 1 mA and automatically switches to standby in the absence of incoming signals. The device receives at 433 MHz and includes an IF amplifier, an AM demodulator, and a clamping comparator for recovering digital data. It works with FM signals when used with an external quadrature detector and handles data rates >10 kbps. The device costs $2.72 (1000) and is available in 16-pin DIP and SO-16 packages. **Temic Telefunken**, Heilbronn, Germany. (049 7131) 67 27 47.
Circle No. 447

PC chip set targets subnotebooks. The QuadNote chip set provides system and peripheral functions for subnotebook computers based on the 486SL processor. The set includes the VL82C410 system controller and the VL82C142 peripheral controller in 176-pin thin quad flatpacks. The optional VL82C146 Personal Computer Memory Card International Association (PCMCIA) controller completes the set. The set's capabilities include a DRAM controller, a real-time clock, an ECP paral-

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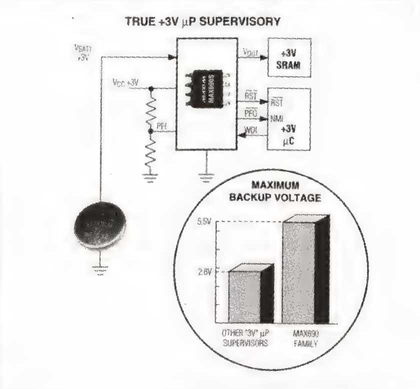
lel port, keyboard- and floppy-disk-controller interfaces, and IR-communications logic. The set works with 3.3 and 5V processors operating as fast as 33 MHz. Price is $51; the PCMCIA interface adds $8.50. **VLSI Technology Inc**, Tempe, AZ. (602) 752-8574. **Circle No. 448**

Codecs offer single-rail operation. A family of 12 codecs (coder/decoder) provides single-rail operation for 5 and 3V designs. The devices use adaptive-differential pulse-code-modulation compression. They also encompass A-Law, µ-Law, and switchable PCM for cellular designs. The devices are available in TSOP packages, and prices start at $4.50 (1000). **Oki Semiconductor**, Sunnyvale, CA, (800) 654-6388. **Circle No. 449**

Video-windowing IC cuts costs. The NMG662534 IC, designated the WatchIT! Pro, provides video windowing and overlay. The device handles a 1024×768-pixel noninterlaced VGA display. It digitizes NTSC, PAL, and SECAM video frames into RGB, YUV 2:1:1, or YUV 4:2:2 formats and provides AVI video capture. The device also provides a direct ISA- or EISA-bus interface with automatic I/O configuration. Reference designs for TV-in-a-window, AVI video capture, and MPEG-playback boards are available. The chip costs $19 (10,000). **New Media Graphics Corp**, Billerica, MA. (508) 663-0666. **Circle No. 450**



µP supervisors switch 3V systems. The MAX690RST/802/RST and MAX-804RST/805RST µP supervisors offer battery-backup switchover only when the main supply has fallen below 2.4V. The ICs provide a reset output during power-up, power-down, and brownout conditions; battery-backup switching for CMOS RAM, CMOS µP, and other low-power logic; a reset pulse if the watchdog timer has not been toggled within 1.6 sec; a 1.25V threshold detector for power-fail warning or low-battery detection or for monitoring a power supply other than 5V. Prices start at $3.23 (1000). **Maxim Integrated Products**, Sunnyvale, CA. (408) 737-7600, ext 6087. **Circle No. 451**

DC/DC converter outputs 5V at 600 mA from two cells. The LT1302 dc/dc converter offers efficiency as high as 87%. Quiescent current is 200 µA, which you can reduce to 15 µA using a logic-controlled shutdown. The IC automatically shifts between burst-mode operation at light loads to current-mode operation at heavy loads. An on-chip low-loss npn power switch handles current >2A and switches at frequency up to 400 kHz, enabling the use of very small surface-mount inductors and capacitors. The device comes in 8-pin DIPs and SOICs; respective prices are $3.21 and $3.35 (1000). **Linear Technology Corp**, Milpitas, CA. (408) 432-1900. **Circle No. 452**

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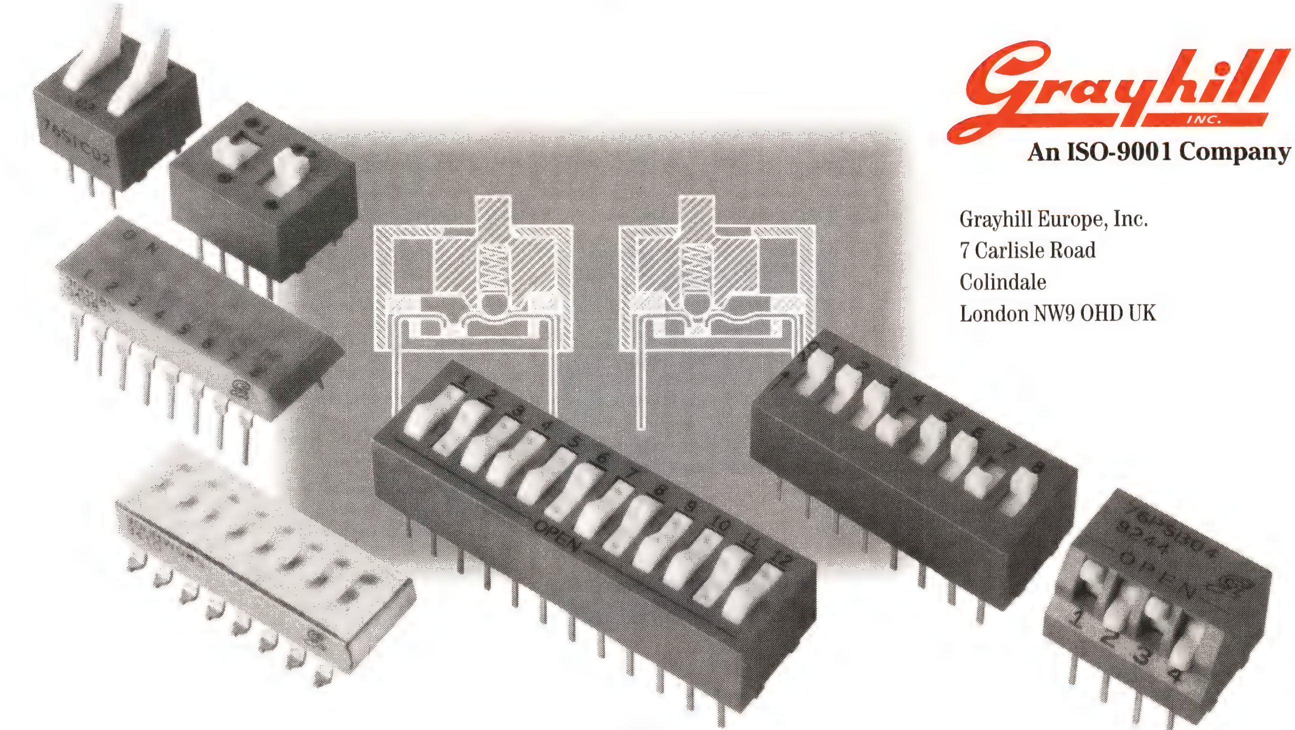

CIRCLE NO. 38

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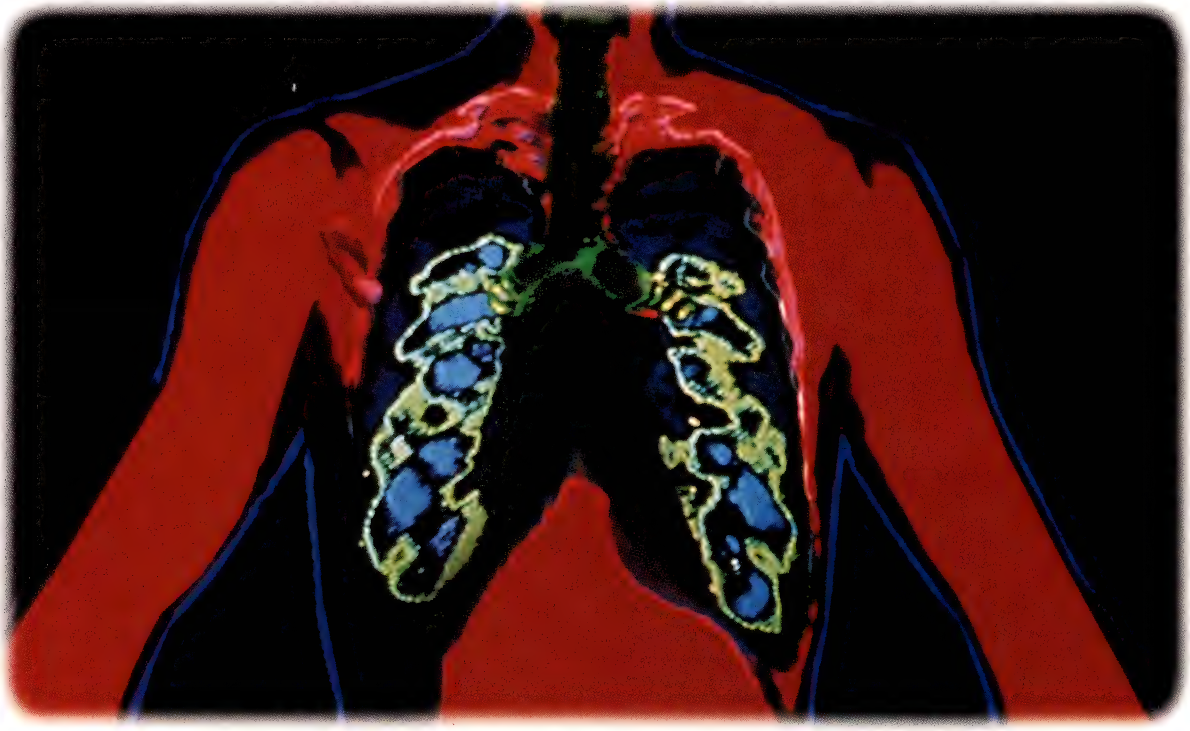

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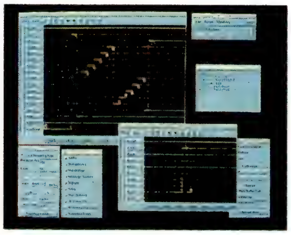

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CIRCLE NO. 26

INTEGRATED CIRCUITS

12-bit, 5-MHz ADC quells noise. The AD871 ADC for imaging applications features an rms noise of 0.16 LSB referred to the input, which is equivalent to one-sixth of a bit at code transitions. This low noise ensures a constant digital output for a constant intensity input, avoiding flicker and snow. The IC's S/N ratio plus distortion is 68 dB at 750 kHz. The vendor guarantees no missing codes. The ADC includes a laser-trimmed voltage reference and a T/H amplifier that typically settles from a full-scale input step to 12-bit accuracy in 80 nsec. In a 28-pin DIP or 44-pin leaded chip carrier, the ADC costs $95 (1000). **Analog Devices**, Wilmington, MA. (617) 937-1428. **Circle No. 459**

Host-adapter IC handles fast SCSI-2. Providing EISA/ISA and fast SCSI-2 interfaces on a single chip, the FAS408 IC offers a 10-Mbyte/sec data-transfer rate. The device connects directly to the PC bus, eliminating the

SHORTS

Both AT&T Microelectronics and SGS-Thompson have demonstrated decoder ICs that handle real-time MPEG-2 decompression. The devices are aimed at direct-broadcast satellite video-decoder applications and are in the alpha sampling stage. **AT&T Microelectronics**, (800) 372-2447. **SGS-Thompson**, +39-39-6035-597. **Circle No. 453**

Micrel Semiconductor now manufactures second sources for the LM4040 and LM4041 precision voltage references. Accuracy for both versions are ±0.1 to ±2%. **Micrel Semiconductor**, (408) 944-0800. **Circle No. 454**

A lower-power version of the MC-145472 ISDN U-interface transceiver is available. The MC-14LC5472 version has a maximum power consumption when active of 500 mW compared with 700 mW for the original device. $35.41 (1000). **Motorola Microcontroller Technology Group**, (800) 422-6323. **Circle No. 455**

The MIC2172/3172 family of PWM switching regulators act as second sources for the LT1172 family. The MIC3172 draws just 1 µA in shutdown. $2.25 (1000). **Micrel Semiconductor**, (408) 944-0800. **Circle No. 456**

The dual-sourced MU9C9240 Wide-Port SYNDAC combines a 24-bit pixel input port with a clock synthesizer and RAMDAC on the same IC. The device comes in four dot-clock versions: 90, 100, 125, and 135 MHz. **Music Semiconductors**, (719) 570-1550. **Oak Technology Inc**, (408) 737-0888. **Circle No. 457**

Linear and switcher development boards are now available to ease designs of the bq2005 dual-battery fast-charge IC. The $99 DV2005SI and DV2005LI incorporate a bq2005 IC controlling a buck-type switch-mode regulator for highest efficiency applications or a frequency-modulated linear- current regulator for lower-cost linear applications, respectively. **Benchmarq Microelectronics Inc**, (214) 407-0011. **Circle No. 458**

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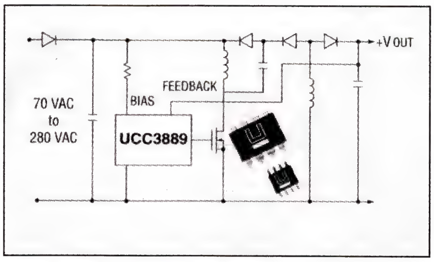
CIRCLE NO. 46

need for a card interface, and includes support logic for a BIOS ROM and a floppy-disk controller. The device has 256 bytes of scratchpad RAM and 128 bytes of FIFO buffering for data transfers to the bus. It comes in a 100-lead plastic quad flatpack and costs $22 (1000). **QLogic Corp**, Costa Mesa, CA. (714) 438-2200. **Circle No. 460**

Power-supply controller discards transformer. Using two cascaded flyback converters, the UCC3889 power-supply controller develops a regulated 12 or 18V-dc output from a wide input range, typically 100 to 400V dc. The IC produces <18V outputs using a simple voltage divider. The controller requires one switch connected to the low side and two surface-mount inductors. It works directly off an ac line and does not require a transformer. Start-up current is 150 μA; run current is 1.5 mA. The output sinks and sources 200 and 150 mA, respectively. It is available in DIPs and SOICs; the DIP version costs $1.25 (1000). **Unitrode Integrated Circuits Corp**, Merrimack, NH. (603) 424-2410. **Circle No. 461**



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CIRCLE NO. 39

Low-dropout regulators consume 1.1 μA with no load. The TC55RP series can source up to 200 mA with an I/O voltage differential of 380 mV. At 100 mA of output current, the dropout voltage is 120 mV. The standard voltage accuracy is ±2% with a custom option of ±1%. The series includes devices with output voltages of 5, 4, and 3; and you can order custom voltages from 1.1 to 9.9V in 0.1V steps. Packaging options include SOT-23, SOT-89, and TO-92. In small quantities, the surface-mount version costs $0.70, and the TO-92 package costs $0.65. **TelCom Semiconductor Inc**, Mountain View, CA. (415) 968-9252. **Circle No. 462**

12-bit ADC cuts power and price. At $5.25 (1000), the TLC2543 ADC costs approximately the same as many currently available 10-bit converters. Power consumption is 5 mW typ and 12.5 mW max. During power-down, consumption is 125 μW max. Conversion time is 10 μsec over the commercial and industrial temperature ranges. Key features are 11 analog inputs, an inherent S/H amplifier, a clock, and three integrated self-test modes. **Texas Instruments**, Denver, CO. (800) 477-8924, ext 4500. **Circle No. 463**

Off-line power-supply chip set operates at 1 MHz. This off-line power-supply chip set comprises the LM3001 primary-side driver and the LM3101 secondary-side driver. The chip set provides the control and drive circuitry for isolated off-line power supplies using magnetic ac feedback from output to input. The 3001 provides system start-up, switch control, and primary-side protection for an isolated converter. The 3101, a precision high-speed PWM controller, provides secondary-side feedback using pulse communication to the primary-side driver. The set comes in 14-pin DIP and SOIC

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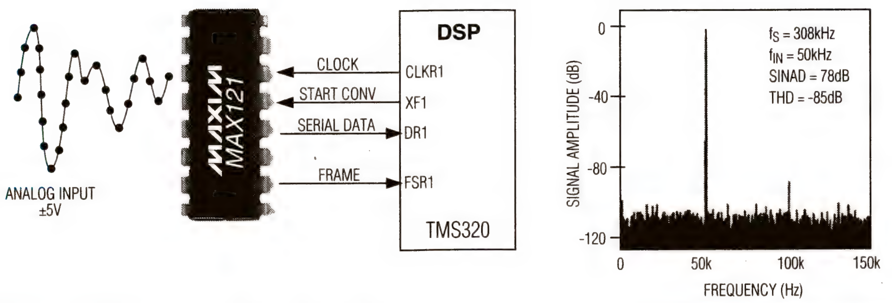

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CIRCLE NO. 154

packages; DIP versions cost $1.60 and $1.45 (1000) for the 3001 and 3101, respectively. **National Semiconductor**, Santa Clara, CA. (408) 721-6937. **Circle No. 464**

Clocked FIFO buffers run at 70 MHz. The CY7C455, CY7C456, and CY7C457 clocked FIFO buffers operate as fast as 71.4 MHz and have 512×18-, 1k×18-, and 2k×18-bit organizations, respectively. The devices dissipate 450 mW and are available in 52-pin plastic quad flatpacks. The devices feature flags that indicate when the FIFO is empty, almost empty, half empty, almost full, and full. The almost-empty and almost-full flags are programmable. All flags are synchronous, which guarantees that they remain valid for at least one cycle. A 33-MHz CYC455 in a plastic leaded chip carrier costs $17.65. **Cypress Semiconductor**, San Jose, CA. (408) 943-2600. **Circle No. 465**

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SHORTS

Micro Power Systems has reduced the price of its MP574A/674/774 12-bit ADCs and MP7226/7228 8-bit DACs. The ADCs range from $9.68 to $17.23 (1000). The DACs sell for $8.20 and $14.40 (1000), respectively. **Micro Power Systems**, (408) 727- 5350. **Circle No. 466**

The MAX730A family of PWM step-down dc-dc converters are drop-in replacements for the company's MAX-730 series. They deliver up to 50% more output current, are free of subharmonic switching noise, and maintain efficiency as high as 94%. $2.60 (1000). **Maxim Integrated Products**, (408) 737-7600, ext 6087. **Circle No. 467**

The 950- to 1450-MHz ADC20014 DBS tuner IC comes in a 16-pin SOIC package. Key specifications include 10-dB noise figure and 5-dB conversion gain. **Anadigics**, (908) 668-5000. **Circle No. 468**

The enhanced A version ($2.13 for 10,000) of the XR-T65118 speakerphone IC features lower power consumption of 6.5 mA max and wider temperature range (down to –20°C) than the original device. The sleep-mode supply current of 600 μA is also 60% lower. **Exar Corp**, (408) 434- 6400. **Circle No. 469**

The MAX351/352/353 ($1.76 (1000)) quad-precision analog switches have <35Ω on-resistances and 2Ω matching between channels. The 8-channel MAX335 ($2.84 (1000)) SPST switch has a serial digital interface and can handle ±15V swings. **Maxim Integrated Products**, (408) 737-7600, ext 6087. **Circle No. 470**

Burr-Brown Corp's DAC7528 dual 8-bit CMOS multiplying DAC is a pin-for-pin replacement of the industry-standard DAC7528. Features include ±1/2 LSB linearity, double-buffered data latches, single 5V operation, and 4-quadrant multiplication. Prices start at $4 (100). **Burr-Brown Corp**, (800) 548-6132. **Circle No. 471**

Weitek Corp has begun shipping its Power 9100 graphics-controller chip in large volumes. The chip costs $70 in large quantities. **Weitek Corp**, (408) 738-8400. **Circle No. 472**

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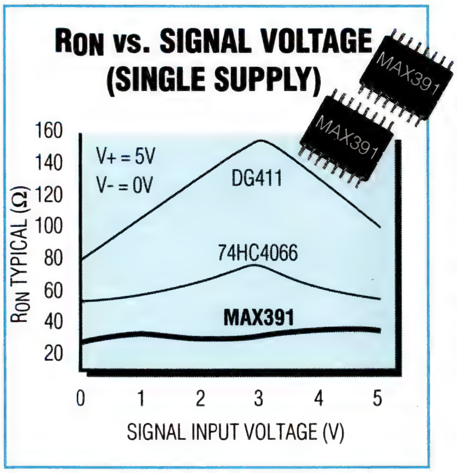
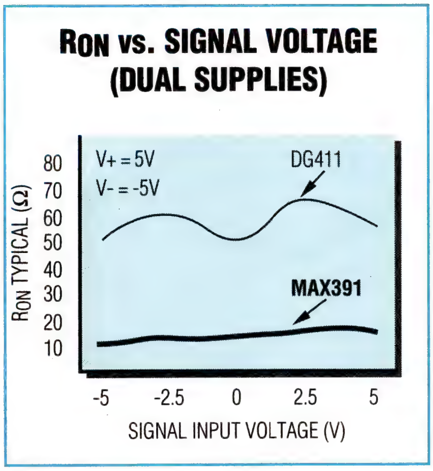


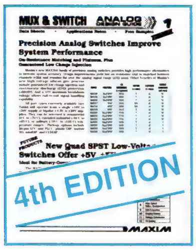
The new MAX391/MAX392/ MAX393 quad CMOS SPST switches are fully specified for +5V and ±5V operation. With 2Ω max RON matching, 6Ω max RON flatness, and 0.5µW power consumption, these switches are ideal for low-voltage, high-accuracy data acquisition and audio signal routing applications. All switches are pin-compatible with industry-standard devices and operate over a wide +3V to +15V or ±3V to ±8V supply range.



Low-Voltage Switches Offer Improved Parameters!

Device*	RON (Ω) max	ΔRON Match (Ω) max	RON Flatness (Ω) max	Leakage (pA) max	Charge Injection (pC) max	tON (ns) max	tOFF (ns) max
±5V Operation							
MAX391 Quad, SPST, NO	30	2	4	100	5	130	75
MAX392 Quad, SPST, NC	30	2	4	100	5	130	75
MAX393 Quad, SPST, 2-NO,2-NC	30	2	4	100	5	130	75
+5V Operation							
MAX391 Quad, SPST, NO	60	2	6	100	5	130	50
MAX392 Quad, SPST, NC	60	2	6	100	5	130	50
MAX393 Quad, SPST, 2-NO,2-NC	60	2	6	100	5	130	50

**NO = Normally Open, NC = Normally Closed*



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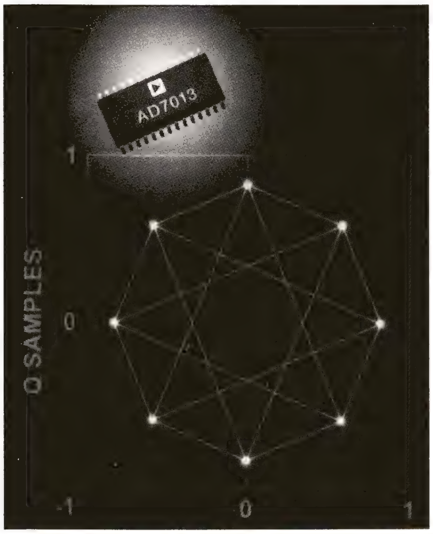
Cache-data RAMs operate with 486 and Pentium μPs. The W73B586 family of cache-data RAMs have access times of 9, 10, 11, and 12 nsec. The synchronous burst-cache RAMs are organized as 32k×8 bits and operate with i486 and Pentium μPs. The devices have a synchronous self-timed write cycle and an asynchronous output-enable pin. Setup and hold times are 2.5 and 0.5 nsec, respectively. Current draw is less than 380 mA for the 9- and 10-nsec versions. $100 for 9-nsec version (1000). **IC Works Inc**, San Jose, CA. (408) 922-0202. **Circle No. 473**

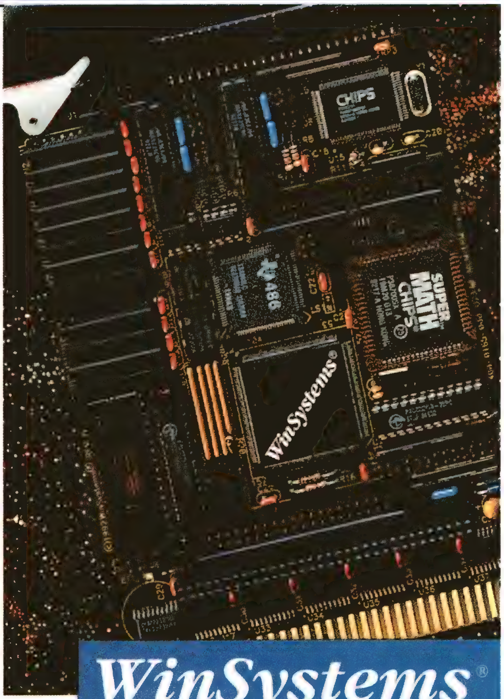


Receive-port IC operates with IS-54 cellular phones. The AD7013 digital baseband receiver port suits digital cellular handsets. The device captures, digitizes, and filters in-phase and quadrature signals using two sigma-delta ADCs. It suits American digital cellular-radio (IS-54) and analog standards. The chip dissipates 45 mW in operating mode and 25 μW in shutdown mode. The chip also contains two 8- and one 10-bit DACs for RF-control functions. $6.30 (1000). **Analog Devices**, Wilmington, MA. (617) 937-1428. **Circle No. 474**

FIFO buffer reconfigures data between LANs. The SN74ABT3614 internetworking FIFO buffer automatically reconfigures data transmitted between LANs using different protocols. The device allows data to be transferred between reduced- and complex-instruction-set-computer μPs and dynamically matches the networks' bandwidths. When data is moving between Motorola and Intel μPs, the chip effectively swaps big- to little-endian bytes. Speed ranges from 15 to 30 nsec. A 15-nsec device in a plastic quad flatpack sells for $44.21 (1000). **Texas Instruments**, Denver, CO. (800) 477-8924, ext 4500. **Circle No. 475**

Flash memory doubles density. The M5M28F016 16-Mbit flash memory doubles the memory density of an existing 8-Mbit design. The device has a 2M×8-bit organization divided into 32 symmetrical 64-kbit blocks. It features a 100-nsec read-access time at 3.3V and has a deep-power-down mode of 3.6 μW. The memory erases and programs using 12V and features automated write and erase and erase-suspend, and 100,000 erase/program cycles/block typ. $90 (10,000). **Mitsubishi Electronics America Inc**, Sunnyvale, CA. (408) 730-5900. **Circle No. 476**

Clock drivers operate from 3.3V. The SC33XX series of 3.3V clock drivers suits applications requiring low-voltage-TTL (LVTTL)-compatible I/O levels. The SC3306 provides 10 outputs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at one-half the input frequency and 10 outputs that match the input frequency. The SC3308 and SC3318 supply 20 and 10 outputs, respectively, that mirror the input frequency. Each of the drivers operates at 80 MHz. All outputs within a group of five exhibit a skew of <250 psec. Slew matching between all outputs is 500 psec. Edge rates are <1.5 nsec for driving Pentium µPs. A 20-output device costs $13 (10,000). **Applied Micro Circuits Corp**, San Diego, CA. (619) 450-9333. **Circle No. 477**

Hyper-page-mode DRAMs store 16 Mbytes. A family of hyper-page-mode dynamic RAMs (DRAMs) offer 16-Mbyte storage and 33- to 50-MHz speeds. The hyper-page-mode design uses a circuit that reduces cycle time during reads. The device is compatible with industry-standard fast-page-mode DRAMs. The DRAM is available in 4M×4-, 2M×8-, and 1M×16-bit organizations, each available in 3.3 or 5V versions having varying refresh rates. The 1M×16-bit version offers two byte-control variations. A 4M×4-bit version costs $80 in sample quantities. **NEC Electronics Inc**, Mountain View, CA. (800) 366-9782. **Circle No. 478**

Flash-memory module comes in small package. The 128×32-bit WF family of CMOS flash PROMs comprise eight equal-sized, 16-kbyte sectors that can be independently updated or erased. The 4-Mbit modules operate from 5V and come in a 5.5-mm-high hermetic ceramic package measuring 35 mm². The vendor guarantees the modules for a minimum of 100,000 erase/program cycles. The modules come in access times of 60, 90, or 120 nsec, and standby current is 1 mA. A 68-pin ceramic-quad-flatpack military-temperature model costs $500 (100). **White Technology Inc**, Phoenix, AZ. (602) 437-1520. **Circle No. 479**

SHORTS

Analog Devices has certified three of its high-speed, high-resolution converters to MIL-STD-883. The AD773ASD/883B ($150 (100)) 10-bit ADC is an upgraded version of the AD773 with a faster conversion rate of 20M samples/sec and 1.25W maximum power consumption. The 16-bit AD660SQ/883B ($69.50) is monotonic to 15 bits. The 14-bit AD679SD/883B ($146) converts 128k samples/sec and includes an 8-bit bus interface, a precision 5V reference, and a clock generator. **Analog Devices Inc**, (617) 937-1428. **Circle No. 480**

Motorola has boosted production of its 64k×18-bit SRAMs. The 9-nsec devices match the bus interfaces of the PowerPC 601 (MCM67M618) and the Pentium (MCM67B618) µPs and cost $55 (1000). The production boost comes from reallocating capacity at Motorola's MOS 11 wafer-fab site. **Motorola Inc**, (512) 933-4141. **Circle No. 481**

Toshiba has developed an MPEG-II decoder circuit that handles images as large as 1152×1024 pixels at 30 frames/sec. The company will incorporate the design into ASICs scheduled for release late this year. **Toshiba America Electronic Components Inc**, (714) 455-2000. **Circle No. 482**

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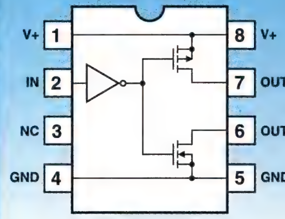

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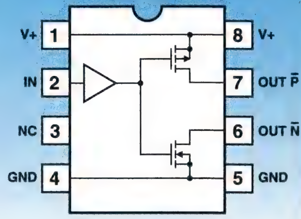
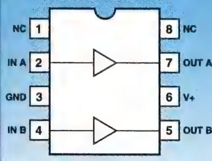


Inverting
- Isolated Drains
- 20 ns Switching Time
- $1.96 – 100's P-DIP

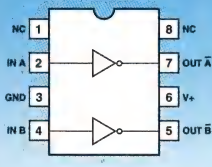
Dual Channel, 2.0 Amps Output

EL7202



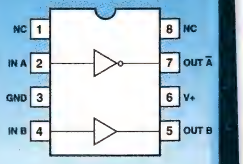
Non-Inverting
- 20 ns Prop Delay
- 20 ns Switch. Time
- $1.96 – 100's P-DIP

EL7212



Inverting
- 20 ns Prop Delay
- 20 ns Switch. Time
- $1.96 – 100's P-DIP

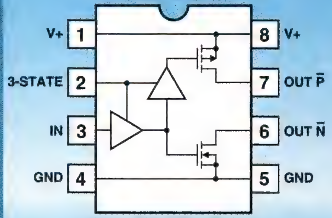
EL7222



Complementary
- 20 ns Prop Delay
- 20 ns Switch. Time
- $1.96 – 100's P-DIP

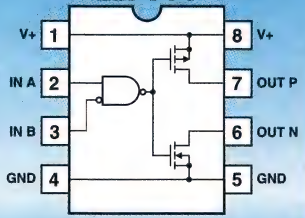
3-State Line Driver/Dual Input Line Driver, 4.0 Amps Output

EL7134



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.40 – 100's P-DIP

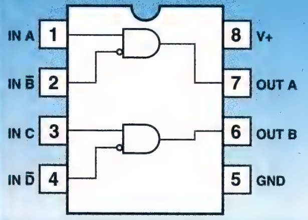
EL7144



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.40 – 100's P-DIP

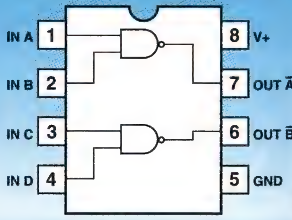
Dual Channel/Dual Input, 2.0 Amps

EL7242



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

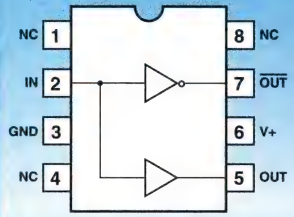
EL7252



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

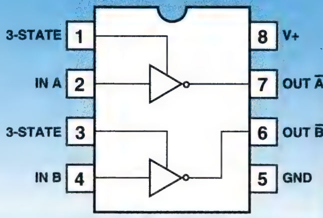
CCD Driver/Dual Channel 3-State Line Driver

EL7182



- Reduced Clock Skew
- 20 ns Switching Time
- $2.65 – 100's P-DIP

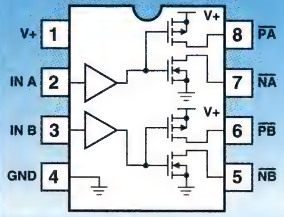
EL7232



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

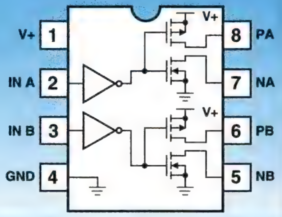
Dual Channel – Isolated Drains, 2.0 Amps

EL7262



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

EL7272



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

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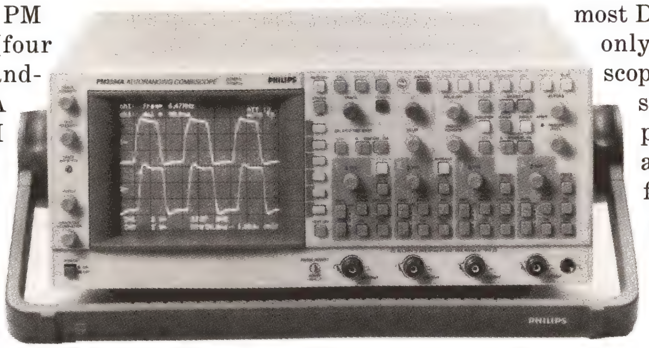
CIRCLE NO. 117

Analog/digital scope autoranges on both time and voltage axes



"Keeping your signals in the picture" is the motto of Fluke Corp's PM 33xxA CombiScopes. Thanks to an onboard 40-MHz DSP, the 100- and 200-MHz-bandwidth analog/digital scopes offer not just autosetup but true autoranging on both axes.

Fluke Corp calls its $6675 PM 3394A CombiScope (four channels, 200-MHz bandwidth) as well as its PM 3384A (four channels, 100 MHz), PM 3392A (two full-featured channels and two channels with limited attenuation, 200 MHz), and PM 3382A (same, 100 MHz) the first *benchtop* scopes to offer full autoranging. Autoranging is a fast-responding extension of the automatic-setup feature found in most scopes for over a decade. The honors for the first scope of any type to offer autoranging appear to go to the handheld TekMeter (from $859), which Tektronix introduced this year. The TekMeter competes with Fluke's wildly popular ScopeMeter.

If your reaction is "ho-hum," you need to see the new scopes' autoranging in action. With the feature disabled, if a signal's amplitude changes enough to make you want to change the scale (that is, if a high amplitude drives the trace beyond the top or bottom of the viewing area or if the amplitude drops to less than one-third of the viewing area's height), pushing the "autosetup" button gets the trace back in about 10 sec. With autoranging enabled, range changes takes place in less than 1 sec. In fact, ranging occurs so rapidly that if you don't look at the range setting—which is always displayed at the bottom of the screen—you may not notice that the picture has been affected by a range change.

In fact, the scope ranges with so little fanfare that you might wish it provided an audible indication each time it changed ranges. Like cars whose automatic transmissions let you choose "performance" or "economy" shift points, these scopes let you custom-tailor the conditions under which ranging occurs. You do it by using the scope's menu system. Another way to achieve tighter control is to use the clever probe. This probe (like a similar one on LeCroy Corp's $4495 ScopeStation) includes a button and a 3-position slide switch that let you select ranges.

Another unusual feature of these scopes is their true variable sweep speed in digital storage oscilloscope (DSO) mode. Unlike analog scopes, most DSOs change their sweep speed only in steps. With many such scopes, you can simulate variable sweep speed by zooming in on a portion of a captured waveform and adjusting the sweep magnification. With the PM 33xxA scopes, however, you can actually vary the sample rate between detent positions. Indeed, you can invoke the variable sweep speed in conjunction with autoranging. For example, if you look at waveforms from a VCO, as you vary the VCO frequency, you can have a single cycle occupy a constant space on the screen. Such a display quickly reveals how the duty cycle varies as a function of frequency.

As the CombiScope name implies, these scopes operate in both DSO and analog modes. You can switch modes by pushing a single button. An onboard DSP operating at 40 MHz enables autoranging, which works only in the DSO mode. As DSOs, the scopes operate in both real-time and random equivalent-time modes. Their waveform memories store 32k samples/channel.

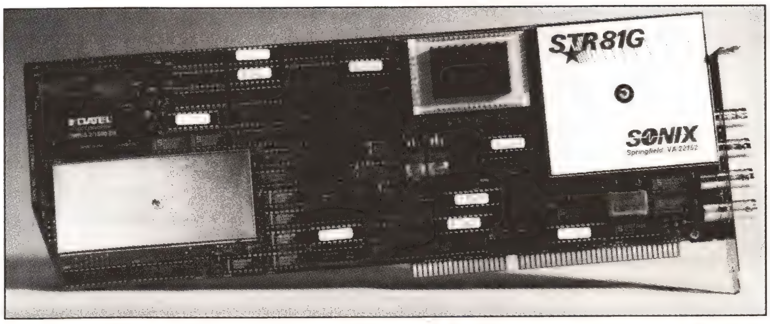
—Dan Strassberg

Fluke Corp, Everett, WA. (800) 443-5853. **Circle No. 372**

LeCroy Corp, Chestnut Ridge, NY. (800) 453-2769. **Circle No. 373**

Tektronix Inc, Beaverton, OR. (800) 426-2200. **Circle No. 374**

1G-sample/sec waveform digitizer also does random interleaved sampling



Benchtop DSOs had better look out; PC-based digitizers are catching up. Sonix's STR*81G not only digitizes to 8 bits in real time at 1G samples/sec, but also offers two equivalent-time-sampling modes, including random-interleaved sampling that lets you see pretrigger events.

With Sonix's announcement of the ISA-bus-based STR*81G, PC-based waveform digitizers have taken not one but two leaps toward the domain of benchtop digital storage oscilloscopes (DSOs). The $6995, 250-MHz-bandwidth board not only samples faster than all but a few benchtop scopes (it takes 1G 8-bit samples/sec in real time), but also does random-interleaved sampling (RIS). Neither the sampling speed nor the RIS capability have heretofore been available in PC-based digitizers. RIS, which in this implementation boosts the effective sampling rate for repetitive signals to 50G samples/sec, allows you to view pretrigger information. You can even set the board to stop acquiring data when it receives a trigger, thus providing an exclusive view of pretrigger data.

You can also set the board to begin acquiring data as much as 65,530 sample periods after a trigger. Because the memory depth is only 8320 samples, viewing a long-duration repetitive phenomenon could require a series of acquisitions, each with a different delay.

The board offers seven trigger modes, including two level-sensitive analog modes that allow setting the trigger level with 8-bit resolution. You can vary the full-scale range from 50 mV to 2V in 16 steps. You can vary the offset as well as the gain within each range in 4096 software-controlled steps. You can also obtain a 10-bit-resolution readout of voltages generated on the board. Together with the programmable gain and offset, this readout capability allows full software-controlled calibration. In addition to RIS, the board provides a second equivalent-time-sampling mode in which a TTL trigger output initiates the external processes that result in waveform iterations.

Acquiring data rapidly is only one consideration in an ISA-bus waveform digitizer. Getting data out of the card at high speeds is equally important. Sonix doesn't require you to use the ISA bus for this purpose, but allows you to do so. A DSP port with its own connector allows 10-Mbyte/sec data transfer to a DSP board such as the vendor's SDC-5600. The digitizer board can simultaneously transfer data via the ISA bus at speeds to 5 Mbytes/sec.

Although high-speed data acquisition usually requires large amounts of power, the STR*81G, which is based on a proprietary hybrid ADC, uses less than 15W. The board has two analog inputs, but it uses relays to switch between them, so that simultaneously acquiring multiple channels at high speeds requires multiple boards.

—Dan Strassberg

Sonix, Springfield, VA. (703) 440-0222.
Circle No. 375

Preselector turns spectrum analyzers into EMC receivers

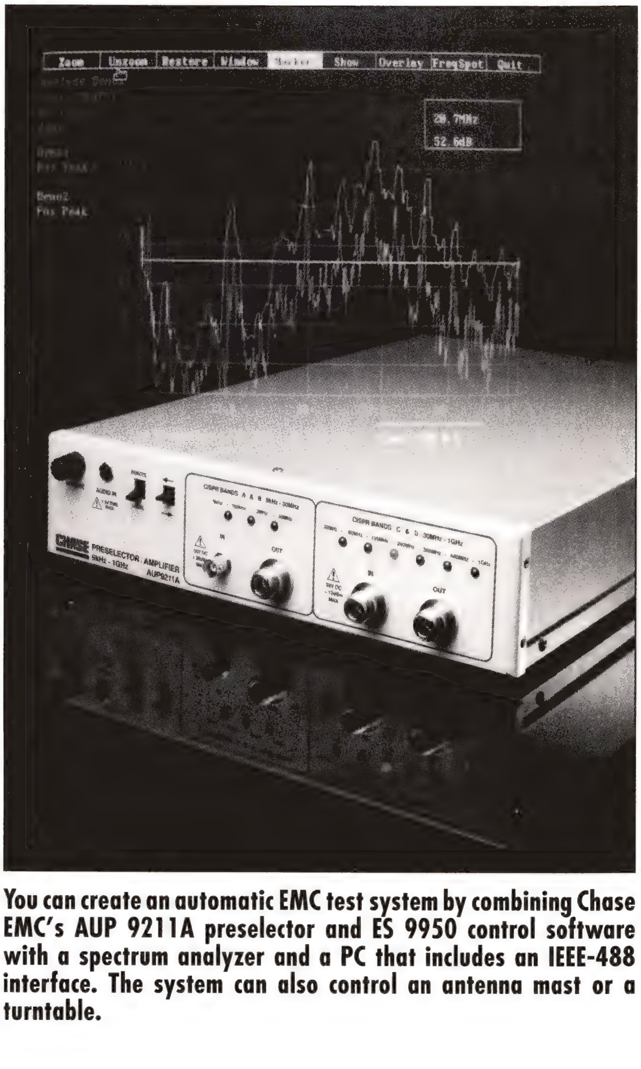
With The AUP 9211A preselector, you can use any spectrum analyzer to measure noise from 9 kHz to 1 GHz. When measuring radiated broadband signals, the preselector inserts one of six passband filters to reduce the total power presented to the signal analyzer's input. This filtering eliminates common and generally unseen errors due to overload in the analyzer's input stages when measuring directly with an analyzer. For radiated signals between 30 MHz and 1 GHz, the preselector has a gain of 12 dB and a noise figure of 8 dB.

For the 9-kHz to 30-MHz conducted-emissions band, the preselector uses one of three filters, and the overall insertion loss is 1.0±0.7 dB. The preselector includes an audio output to help you identify interfering emissions.

Included with the preselector is ES 9950 PC software for automatically controlling the preselector and spectrum analyzer in a closed-loop IEEE-488 measurement system. Currently, the software supports Advantest 3000, HP 8590, and Tektronix 2712 series spectrum analyzers. The software, which can store 7000 measurements for a complete scan, includes common international EMC limit lines and permits presetting of antenna factors. The Preselector and software cost £4750.

—Brian Kerridge

Chase EMC, Bramley, UK. (483) 898969. In US, Ibex Group, Long Valley, NJ. (908) 876-4008.
Circle No. 376



You can create an automatic EMC test system by combining Chase EMC's AUP 9211A preselector and ES 9950 control software with a spectrum analyzer and a PC that includes an IEEE-488 interface. The system can also control an antenna mast or a turntable.

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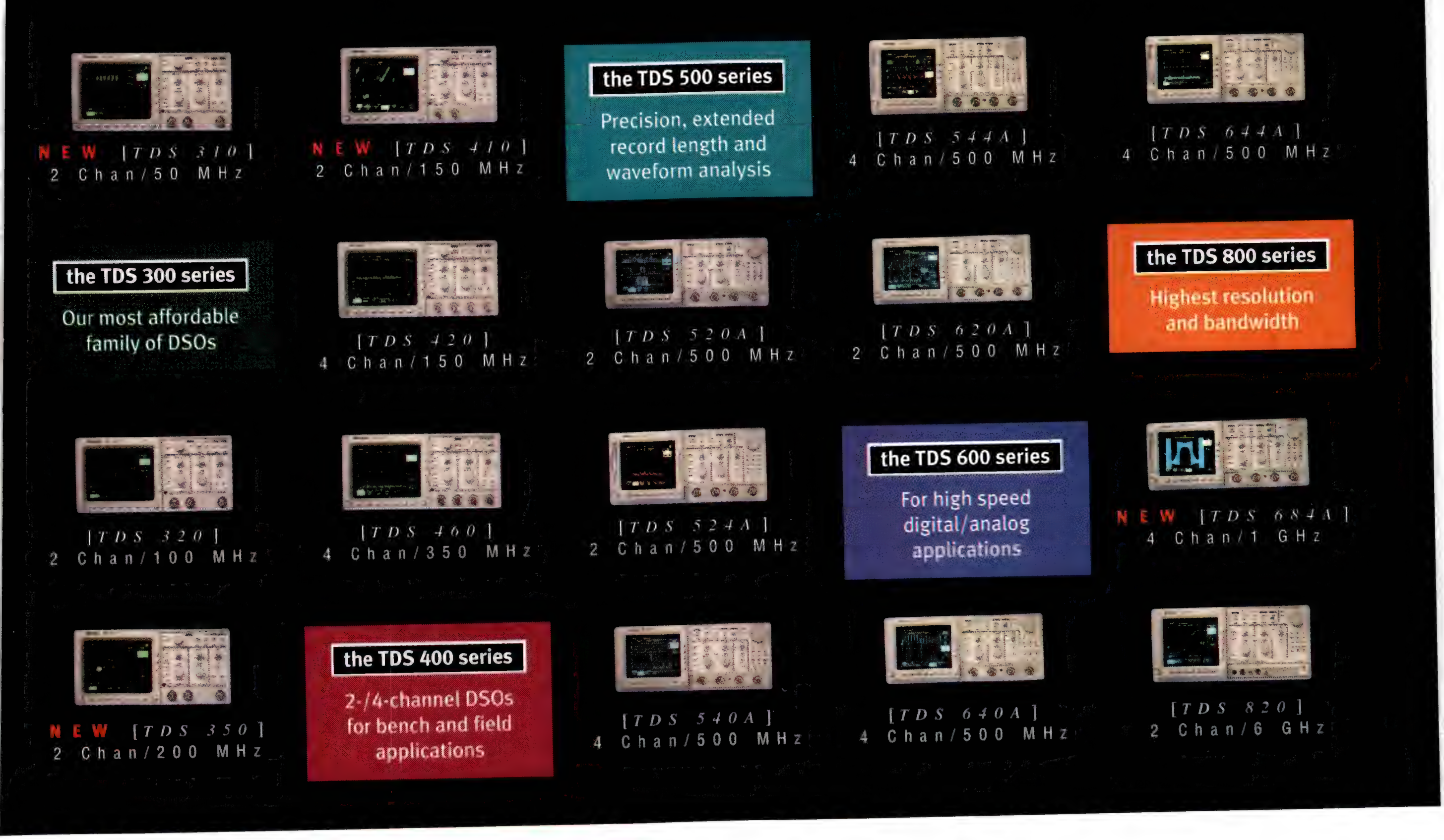
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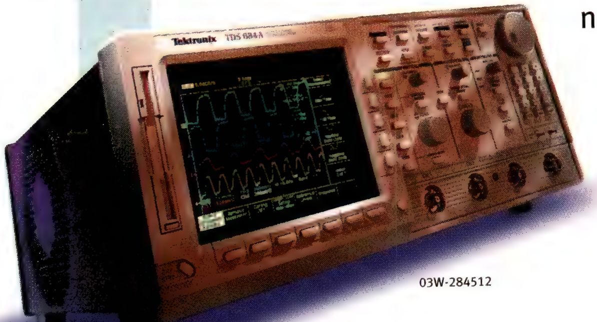

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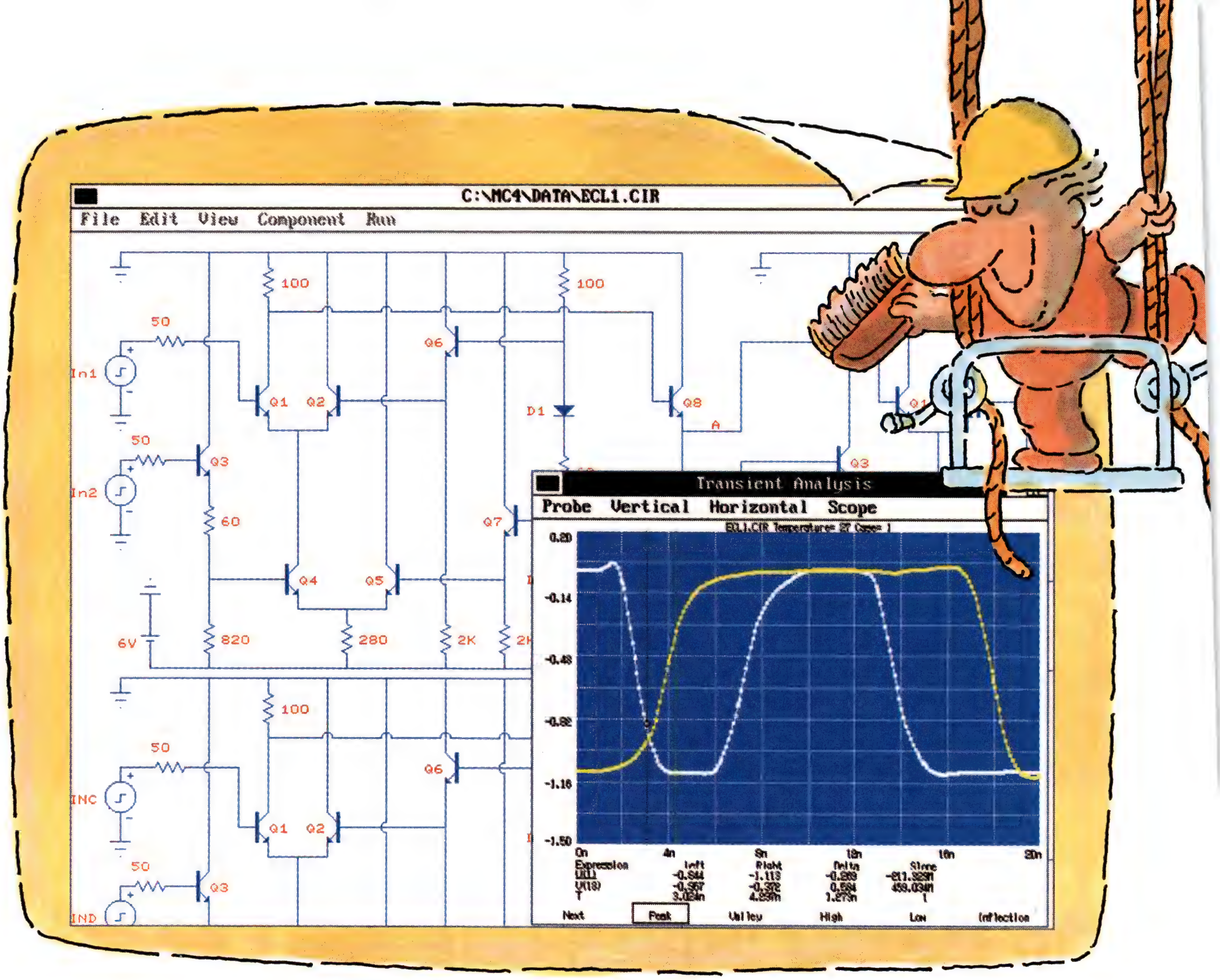
CIRCLE NO. 89



```
Expression      Left      Right     Delta     Slope
V(1)          -0.844     -1.113    -0.268  -211.328M
V(18)         -0.967     -0.372     0.594   459.034M
T              3.028n     4.298n    1.273n  1
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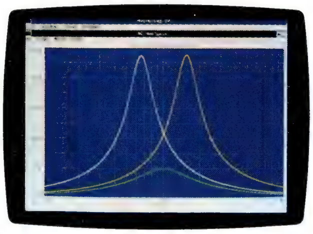
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CIRCLE NO. 200

Software package stores and manipulates waveforms captured by handheld digital storage oscilloscopes. The Waveform Manager software package works with Fluke Corp's ScopeMeters and Tektronix's 222 series of portable battery-powered digital storage oscilloscopes. With the Windows-based package, you can pull several waveforms into a picture via your scope's and computer's RS-232C ports, drag the waveforms into position, resize them, add a few notes, and copy the picture into other applications via the Windows clipboard—all without creating a file. The package, which also converts waveforms into user-configurable data tables that are readable by spreadsheets and math programs, sends waveforms and setups to instruments as well. **Metratek**, Hillsboro, OR. (503) 640-4906. **Circle No. 506**

VXIbus module controls 27 power supplies. The single-width, C-size TMA VXI-27 ($2495) works with supplies that implement the vendor's 2-wire serial bus. Included are the MAT, MST, MBT, and BOP series. The module allows galvanic and thermal isolation of the supplies from the VXIbus and permits bidirectional communication at distances up to 300m. **Kepco Inc**, Flushing, NY. (718) 461-7000. **Circle No. 507**

$545 handheld unit diagnoses common ac-line problems. The Model 120 PowerSpy uses LEDs to display the nature and probable cause of power problems such as sags, swells, impulses, waveshape faults, high-frequency noise, dropouts, and wiring errors. You plug the unit into the ac line and plug a load into its stacking plug. **Basic Measuring Instruments**, Santa Clara, CA. (408) 970-3700. **Circle No. 508**

Data-acquisition-and-control software delivers 100% Windows compatibility. The look and feel of Labtech Notebook V8.0 and Labtech Control V5.0 conform to Windows user-interface conventions. According to Labtech, no other data-acquisition-and-control software offers this level of compatibility. The packages are also fast—they support data streaming up to 1 MHz using Windows DMA—and they incorporate client/server computing features that let you monitor and control processes over local-area networks. Despite the new features, the vendor has lowered prices. Labtech Notebook now costs $495; NotebookPro costs $995. Both prices are less than half those of earlier versions. Labtech Control now costs $1995 and ControlPro is now $3495. **Laboratory Technologies Corp**, Wilmington, MA. (508) 657-5400. **Circle No. 509**

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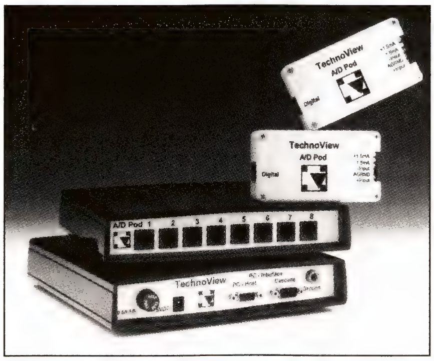


System acquires low-level signals accurately by placing ADCs near signal sources. The A/D Pod Data-Acquisition System consists of several 4.38×2.38×1.22-in. ADC pods and a PC-interface module. The interface module communicates with the host PC at up to 57.6 kbps and with up to eight of the pods. You can daisy-chain as many as 32 interface modules to create a 255-channel system. The pods, which resolve ±18 bits, accept full scale inputs as small as ±0.1463V. There are 13 versions offering different sensitivities. The least sensitive accepts ±2V. Each pod provides a pair of TTL outputs and can supply 1.5 mA for transducer excitation. A 4-channel system costs $4195. **TechnoView Inc**, Newport Beach, CA. (714) 854-5559. **Circle No. 510**

225-MHz universal counter resolves 12 digits/sec. The 53132A can transfer 200 fully formatted measurements/sec via its SCPI-compatible IEEE-488 port. An RS-232C port communicates with printers and with PCs running terminal-emulation software. An optional third channel extends the frequency range to 3 GHz. The unit, which includes statistics and math functions, can measure pulse parameters automatically and can store and recall 20 test setups. $2400. **Hewlett-Packard Co**, Santa Clara, CA. (800) 452-4844. **Circle No. 511**

$429 4½-digit benchtop DMM reads dc with 0.03% error. The BDM40 measures ac and dc voltages to 1200V in five ranges, ac and dc current to 20A in six ranges, and resistance to 20 MΩ in six ranges. It also includes a diode-test function. The display uses 0.5-in.-high LED digits. $429. **Wavetek Corp**, San Diego, CA. (619) 279-2200. **Circle No. 512**

$1599, 100-MHz 3-channel scope displays six traces. The 2190A offers 1-mV/div sensitivity. Sweep speed covers 50 nsec/div to 0.5 sec/div in 22 calibrated steps. The scope includes X-, Y-, and Z-axis inputs as well as two time-base generators. A delay line allows viewing the leading edges of pulses. **B&K Precision**, Chicago, IL. (312) 889-1448. **Circle No. 513**

$149.95, 8-channel, ISA bus ADC board converts to 12 bits in 1 msec; 8 bits in 20 μsec. The 93-326A measures with linearity better than ±1% and accuracy within ±2 counts. You can change the integrating ADC's clock rate from 32 to 100 MHz. With a 100-MHz clock and 8-bit resolution, conversions take 20 μsec. The board also includes a pair of 8-bit TTL ports—one for input; the other for output. **John Bell**, Minden, NV. (702) 267-2704. **Circle No. 514**

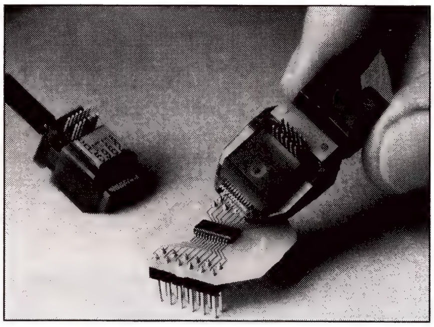
Probes simplify connecting to surface-mount devices whose leads are as close as 0.5 mm. The Wedge Adapter occupies no more surface area than the IC to which you attach it. It derives its name from its use of insulating wedges with conductive material deposited on their sides to make contact with the edges of leads that project from surface-mounted ICs. From $1800. **Hewlett-Packard Co**, Santa Clara, CA. (800) 452-4844. **Circle No. 515**

Software processes DSO-acquired data. Vu-Point, which runs even on 8088-based PCs, operates on data gathered by waveform digitizers, transient recorders, data loggers, and DSOs. Among supported units are ones from Analogic, IES, LeCroy and Nicolet. The package writes data files to disk in DIF, WKS, ASCII, Nicolet, and several compact binary formats. It also sends graphics to many printers and plotters and creates graphics files in such formats as HPGL, PostScript, and PCX.

The software handles data on up to 99 channels and data sets as large as 64M points. $95 (basic edition); $495 (enhanced edition). **S-Cubed,** La Jolla, CA. (800) 621-9240. **Circle No. 516**

Probes provide access to fine-pitch surface-mount ICs. Handheld T-series probes work with devices having leads on 0.65-mm or 0.025-in. centers. The probes provide a row of 32 pins. A comb-shaped guide helps to align the contacts with the IC leads. According to the vendor, one $695 probe can replace four high-density clips, each of which can cost as much as the single probe. **Polar Instruments,** Sumas, WA. (206) 599-1430. **Circle No. 517**

Double-height 6U VMEbus quad DAC board provides isolated outputs. Each of the DVME-621's four 12-bit DACs is powered by a separate isolated dc/dc converter. Channels are isolated from each other and from the VMEbus. Withstanding voltage is 500V rms. In the voltage mode, each output can supply ±100 mA. You can set full-scale to either 0 to 11V or ±11V. In the current mode, the outputs can sink or source as much as 160 mA. $1995. **Datel Inc,** Mansfield, MA. (508) 339-3000. **Circle No. 518**



IC test clips lock onto 20- and 24-pin SSOPs and QSOPs. The 5962A ($150) mates with 0.15-in.-wide 20- and 24-pin QSOPs having pins on 0.025-in. centers. The 20-pin 5969A and the 24-pin 5972A ($165 each) connect to SSOPs that have 5.3-mm-wide bodies and pins on 0.65-mm centers. All of these units lock in place. The vendor will continue to offer slightly smaller units that press into place. **ITT Pomona Electronics,** Pomona, CA. (909) 469-2900. **Circle No. 519**

Test clips contact PQFP leads spaced as close as 0.3 mm. The FOP and FP series include such units as a grabber with a 30-mm tip for use with 0.5-mm lead spacings ($10.50) and an extra-long test probe for PQFPs with 0.3-mm lead pitch ($50.00). **Emulation Technology Inc,** Santa Clara, CA. (408) 982-0660. **Circle No. 520**

Unix- and Mac-based plotting/graphing tool handles extremely large datasets. Spyglass Plot ($295) generates line, double-Y, scatter, and parametric plots. The plots can use different line types, colors, symbols, numbers, and error bars. The software, which fits curves to data, accepts data in many formats. $295. **Spyglass Inc,** Savoy, IL. (217) 355-6000. **Circle No. 521**

Windows-based data-acquisition-and-analysis software supports programmers and nonprogrammers. Because of its modular architecture, you can configure Snap-Master V2.0 to suit your application as well as your style. The package supports data-acquisition boards from a dozen suppli-

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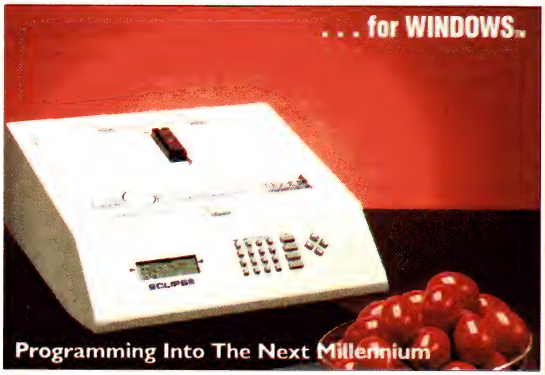

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CIRCLE NO. 65

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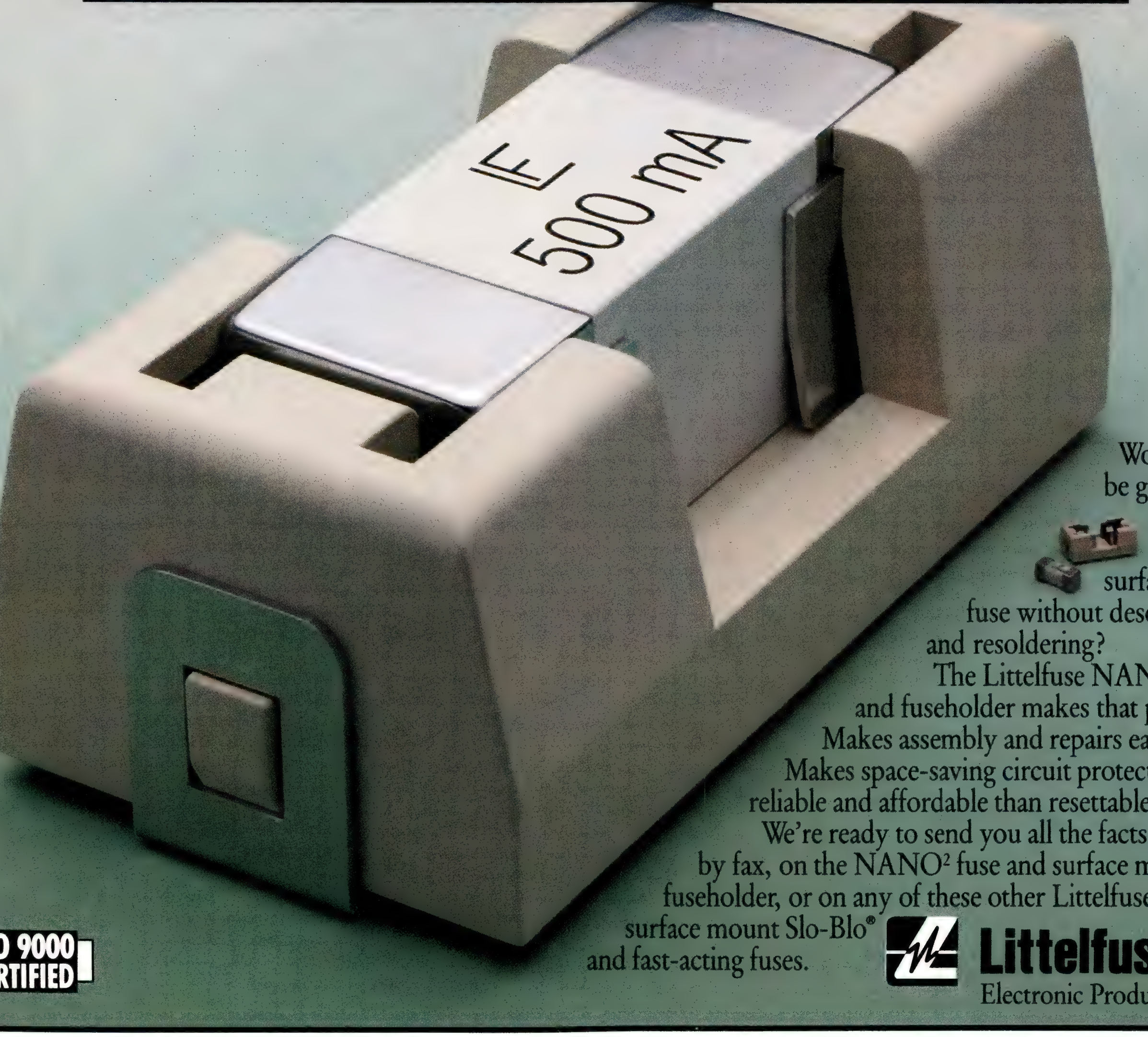

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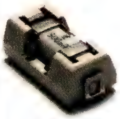
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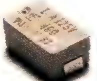
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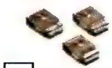
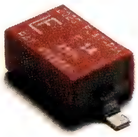
125V


☐ 1206 Case SMF Fast-Acting
2/10-2A
32V

☐ Nanofuse™
1/16-15A
125V, 60V, 32V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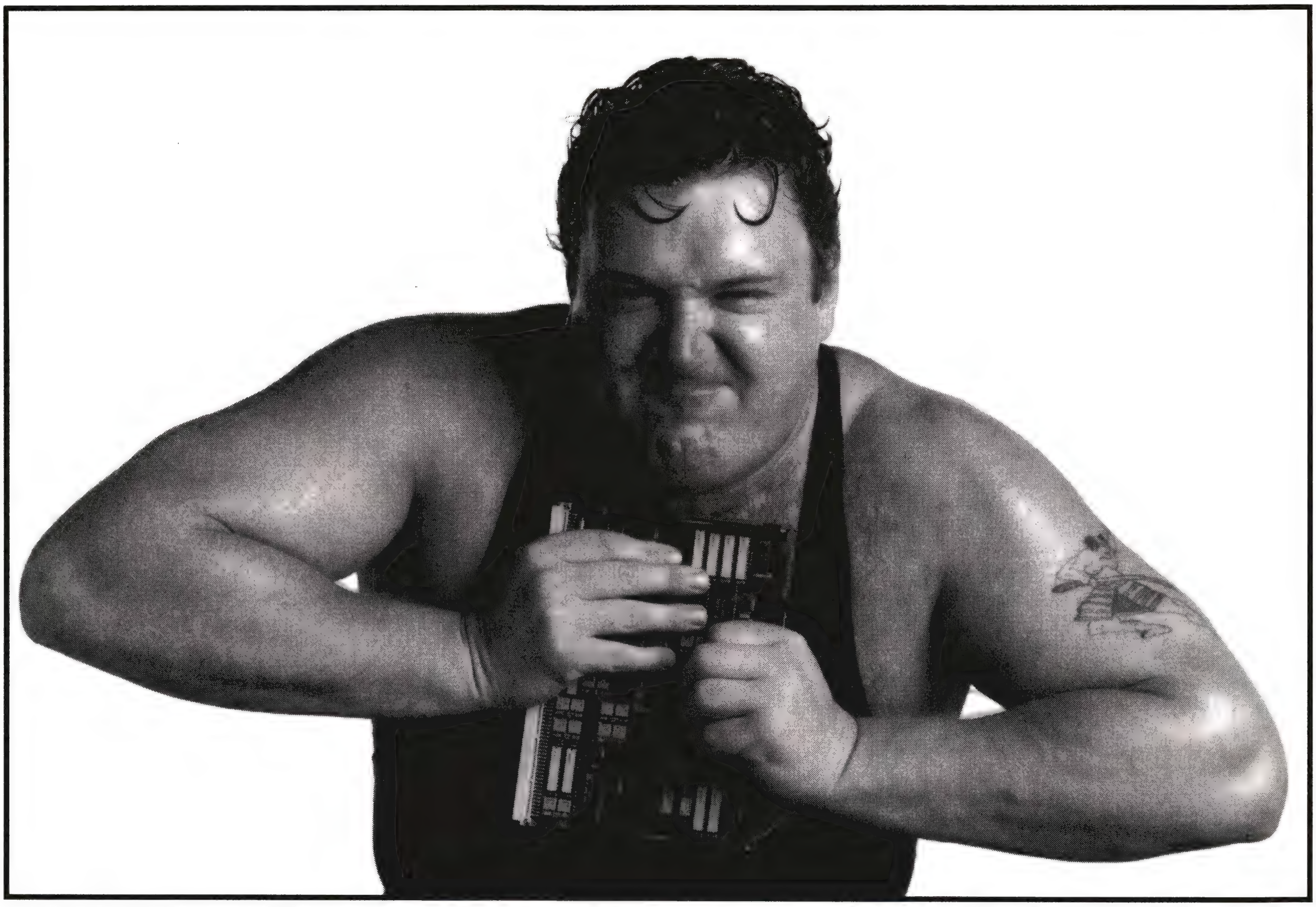
CIRCLE NO. 145



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128Kx32	EDI8F32128C*	12	64 pin ZIP/SIMM
256Kx32	EDI8F32256C*	12	64 pin ZIP/SIMM
256Kx32	EDI8F32257C*	17	64 pin ZIP
32Kx24	EDI8F2432C	15	56 pin ZIP
64Kx24	EDI8F2464C	15	56 pin ZIP
128Kx24	EDI8F24128C	20	60 pin ZIP

Surface Mount Package Styles

Organization	Part No.	Speed (ns)	Package Style
256Kx8	EDI8F8257C*	70	32 pin SOIC
2x512Kx8	EDI9F81025C	55	36 pin SOIC

*JEDEC Pinout

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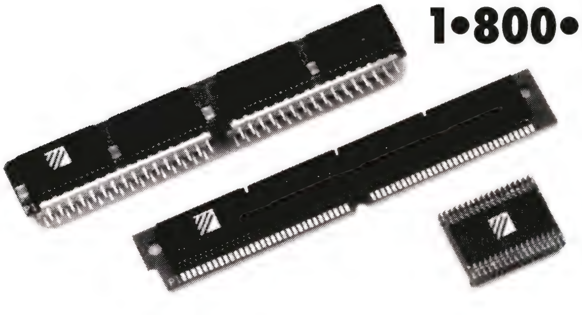

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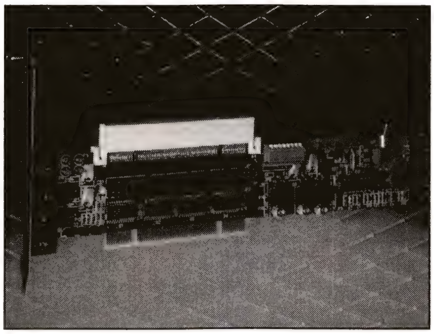
United Kingdom • 0276 472637 • FAX: 0276 473748

CIRCLE NO. 118

ers and also supports signal-conditioning hardware. It can acquire and store data in memory at rates to 1M points/sec and on disk at sustained rates to 180,000 points/sec. $995 to $2775. **HEM Data Corp,** Southfield, MI. (313) 559-5607. **Circle No. 522**

Windows-based software fits curves to experimental data. Scientist for Windows' wide range of user-transparent numeric, symbolic, and data-fitting capabilities differentiate it from less specialized packages that do curve fitting. The software determines best-fitting splines, polynomials, and interpolating functions. It supports complex numbers, if-then-else constructs, and numerous export and import formats. Conventional programming is not required; you enter equations in an intuitive syntax. $295; $249 for academic users. **MicroMath Scientific Software,** Salt Lake City, UT. (801) 943-0290. **Circle No. 523**

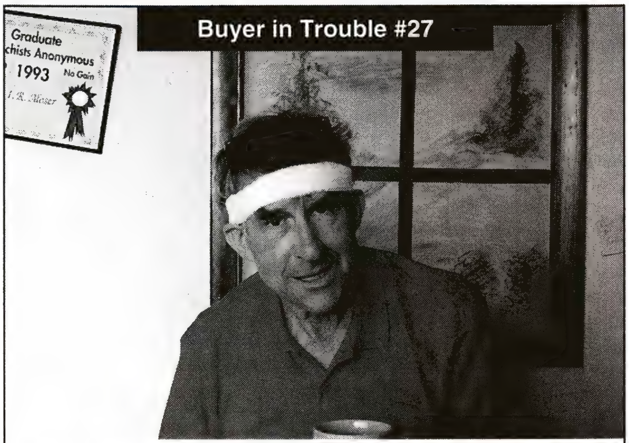
Active extenders allow hot-swapping of 5V and 3.3V PCI bus boards. The PCI-532 works with 5V and universal cards; the PCI-332 works with 3.3V and universal cards. The extenders use a technology called Quick Switch, which allows the board to support DMA and cover the entire address range without your having to change any switch settings or run any software. The extenders, which are <2-in. high, have eight layers, including a solid ground plane. When you turn the on/off switch to OFF, the board isolates all signals and voltages from the board under test. It maintains the isolation until you restore power and the main 5V supply has returned to 90% of its normal value. $395. **Catalyst Enterprises Inc,** San Jose, CA. (408) 268-4145. **Circle No. 524**



SCSI bus analyzer/monitor can use dumb terminal for display. The Pathfinder 2000 is an alternative to a logic analyzer. It captures up to 32 kbytes of single-ended synchronous or asynchronous SCSI events at speeds to 10 Mbytes/sec. The unit has three main capture modes: run, continuous, and trigger, and three trigger modes: start, middle, and end. In monitor mode, it samples the bus every 78 μsec. Every second, it calculates and displays the percentage of bus usage; it also stores this information for printing or further analysis. $1895. **Integrated Resources,** Hurst, TX. (819) 589-1387. **Circle No. 525**

Small board interfaces up to 320 digital I/O lines to an RS-232C port. The I/O Stack is intended for integration into higher level products such as embedded systems. The $495 main board, which needs only 5V power, contains a μP. It connects to the host system's RS-232C port with which it can communicate at speeds to 19.2 kbps. All communication is in the form of ASCII messages. The board accepts eight I/O boards ($295 each). Each con-

Buyer in Trouble #27



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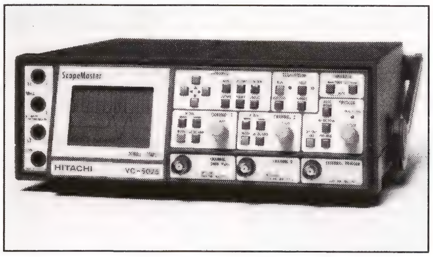
CIRCLE NO. 71

tains five 8-bit TTL I/O ports. **Mill-Race Software**, Manhattan Beach, CA. (310) 546-6737. **Circle No. 526**

Handheld calibration tools provide complete documentation. The 701 ($1995) and 702 ($2995; $3295 with PMlink software) are designed for calibration, maintenance, and troubleshooting of process instruments. The 701's internal memory can save and recall more than a day's calibration data. The 702 offers enhanced accuracy, a larger memory (it stores over a week's data), and an RS-232C interface. The battery-powered units, which operate for eight hours between charges, measure and source voltage, current, resistance, and frequency. They also read and simulate thermocouple outputs. **Fluke Corp**, Everett, WA. (800) 443-5853. **Circle No. 527**



$995 unit combines DSO, DMM, counter-timer, data-logger, and RS-232C analyzer. The 260×250×88-mm, 3.9-lb VC5025 includes a 3000-count DMM that measures resistance as well as ac/dc voltage and current, a 2-channel 10M-sample/sec DSO, an 8-digit 0.001%-error counter/timer that also measures period and RPM, a data logger that records 1000 measurements, a real-time clock, and more. **Hitachi Denshi America Ltd**, Torrance, CA. (310) 328-6116.
Circle No. 528

Test chassis makes PC-hosted SCSI test equipment portable. The 3×6×16-in. PassPort ($1200; $1000 if purchased with any of the vendor's SCSI emulators or analyzers) has three ISA bus slots—two full-length 16-bit and one short 8-bit. The unit connects to a PC's parallel port, but it replicates the port so that you can still connect a printer. Within the limitations of the port bandwidth, boards plugged into the PassPort act as if they were plugged into the PC's ISA bus. **I-Tech Corp**, Edina, MN. (612) 941-5905. **Circle No. 529**

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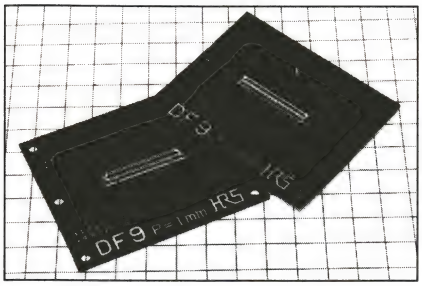
CIRCLE NO. 33

SMT LINE INCLUDES 1mm, 51-CONTACT, BOARD-TO-BOARD CONNECTOR

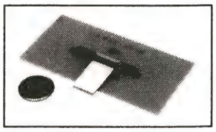


Simi Valley, CA...Hirose Electric (U.S.A.), Inc., is now supplying the DF9 series, a surface mount 1mm center line board-to-board connector which meets the needs for high-speed, high-density, low-cost connectors. The DF9 series employs "gull-wing" type design for PCB contact to ensure reliable performance. The mated height between PCBs is 4.3mm. The contacts were designed to control and accept dimensional changes caused by thermo-elasticity. Reinforcement hardware is provided to eliminate mechanical stress to solder joints during mating and unmating cycles. Available in 9, 11, 13, 15, 17, 19, 21, 23, 25, 31 and 51 positions.

For more information, contact the sales department, **Hirose Electric (U.S.A.)**, (805) 522-7958 or fax (805) 522-3217. For catalog information via fax: 1-800-879-8071. Ask for #5003.

CIRCLE NO. 80

0.5 mm"FLIP-LOCK" SMT/ZIF TYPE FLEXIBLE PC BOARD CONNECTOR

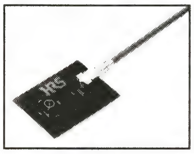


Simi Valley, CA...Hirose Electric (U.S.A.), Inc., is producing the FH12 series of miniature connectors for FPC/FFC use. These newly developed connectors use a "flip-lock" concept and can be used with surface mount technology to prevent problems associated with slide-lock systems. FH12 series connectors have spacing of 0.5mm (0.020") and are suited to high density mounting, with a mounting height of only 2mm. The connector has also been reduced by 1.7mm in length compared to earlier Hirose products. Available with 10, 15, 20, 24, 30, 33, 36, 40, 45, and 50-positions—the FHI2 is ideal for LCD-related uses, as well as portable telephones, CD-ROM and other miniature products.

For further information, contact **Hirose Electric (U.S.A.), Inc.**, (805) 522-7958 or fax (805) 522-3217. For catalog via fax: 1-800-879-8071. Ask for # 6003.

CIRCLE NO. 81

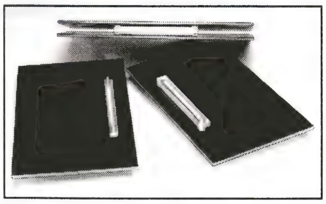
H.FL: World's Smallest SMT Co-Axial Connector



Hirose Electric has introduced its H.FL series SMT low-profile super-miniature coax connector; at a mated height of only 3mm (plug plus board-mount receptacle), it's the world's smallest. Hirose has achieved the higher density by lowering the mated height by 30% and saving 20% of the PCB space taken by its popular S.FL-2 coax connector. The H.FL series offers plug to receptacle mating at 360-degree orientation; solderless crimping for connector to cable termination and a tool for unmating the plug and receptacle. The H.FL coax has high frequency characteristics of DC-3000 MHz/V.S.W.R. below 1.3, for up to 3 GHz. Applications include cellular telephones, radio communications equipment, GPS and other projects requiring small coaxial connectors. For further information, contact **Hirose Electric (U.S.A.), Inc.**, (805) 522-7958 or FAX (805) 522-3217. For catalog information via fax: 1-800-879-8071. Ask for #4002.

CIRCLE NO. 82

High Density 0.8mm Pitch Stacking Connectors



Simi Valley, CA...Hirose is providing a new FX6 series of 0.8mm pitch SMT stacking connectors. They offer lighter weight and higher density for internal mounting required by compact electronic equipment, ranging from notebook computers to personal terminals. A wide variety of FX6 connectors is available with 20, 40, 60, 80 and 100 pins which meet the needs of high-speed LSI designs. Compared to traditional half-pitch (1.27mm) connectors, the FX6 series has about one-quarter the weight and half the mounting area. Stacking heights can be set from 5 to 9mm in 1mm steps. For further information, contact **Hirose Electric (U.S.A.), Inc.**, (805) 522-7958 or FAX (805) 522-3217. For catalog information via fax: 800-879-8071. Ask for #5013.

CIRCLE NO. 83

© 1994 Hirose Electric (U.S.A.), Inc.

Just when you thought you have seen everything in PC card connector technology, Hirose presents more surprises.

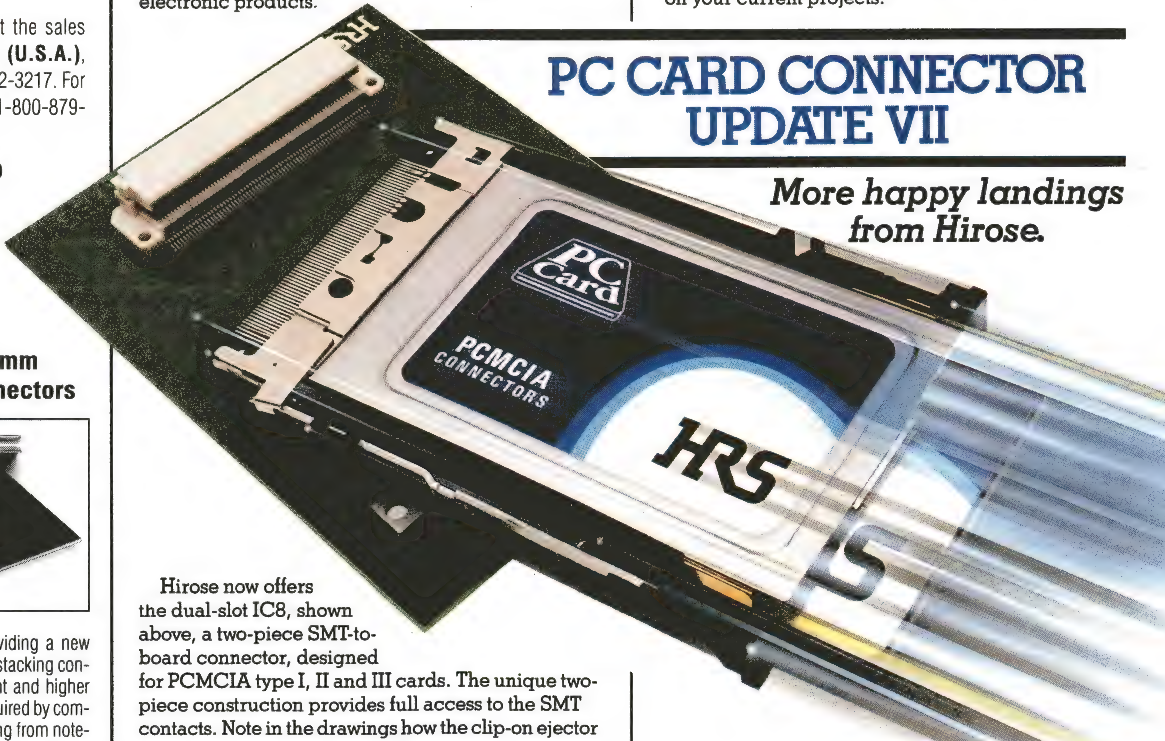
For Hirose customers, though, these compact solutions are expected. Because every day, Hirose helps design engineers package compact memory and I/O capability into sophisticated, compact electronic products.

If you are looking for alternative designs, consider the IC6 series of dual-slot PC card header connectors. These through-hole connectors are available in high-temp or value-engineered versions, and will take Type I, II and III cards.

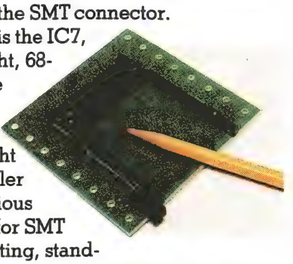
Learn how Hirose can make your PCMCIA card interconnects, with ESD and EMI protection, work on your current projects.

PC CARD CONNECTOR UPDATE VII

More happy landings from Hirose.



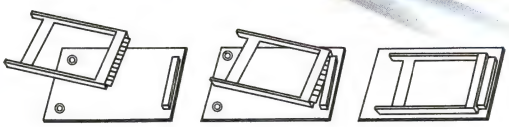
Hirose now offers the dual-slot IC8, shown above, a two-piece SMT-to-board connector, designed for PCMCIA type I, II and III cards. The unique two-piece construction provides full access to the SMT contacts. Note in the drawings how the clip-on ejector moves in to dock with the SMT connector.



Shown on the right is the IC7, a compact, light-weight, 68-pin connector suitable for PCMCIA Type I, II and III cards.

About half the weight and substantially smaller and thinner than previous product, it is suitable for SMT or through-hole mounting, standard or reverse placement under the PCB and with options of left or right hand eject buttons. The choice is yours.

CIRCLE NO. 84



Shown is the IC8, a dual-slot, two-piece, SMT-to-board connector. The SMT portion provides full access for visual inspection of solder terminations.

HRS **Hirose Electric (U.S.A.), Inc.**
2688 Westhills Court, Simi Valley, CA
93065-6235 • (805) 522-7958
FAX (805) 522-3217. For instant fax catalog information: 1-800-879-8071. On the IC6, ask for #8005. On the IC7, ask for #8008, on the IC8, ask for #8009.

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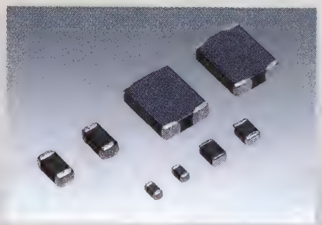
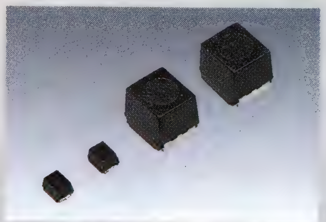
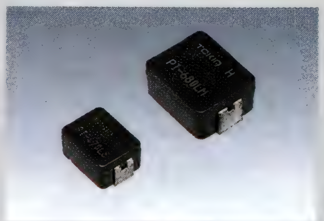


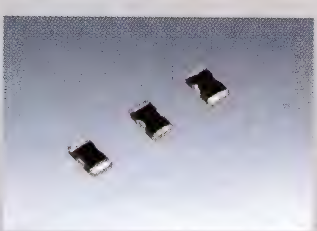
Solid Chip EMI Filters and Common Mode Choke Coils



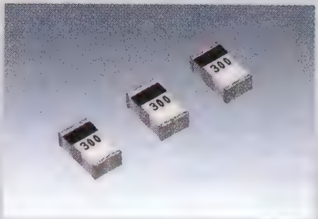
Wire-wound Chip Inductors



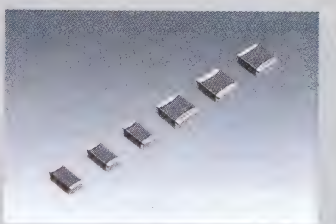
SMD Power Inductors



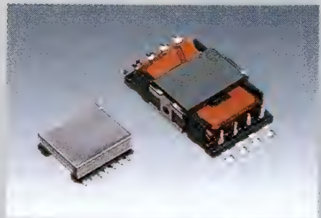
Three-terminal Filter Capacitors



Three-terminal EMI Filters



***Multilayer Ceramic Chip Capacitors**



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CIRCLE NO. 205

CEIBO

DS-186 In-Circuit Emulator

Ceibo DS-186 is a real-time in-circuit emulator dedicated to the 80C186/80C188 family of microprocessors. The emulator provides a versatile and efficient tool for debugging, developing and manufacturing systems designed with these microprocessors. DS-186 operates with an IBM PC or compatible computer through an RS-232 interface. The baud rate is programmable from 9600 Baud to 115 KBaud. The software includes a state-of-the-art source-level-debugger from Paradigm designed to support embedded system applications with the power and flexibiity of the award-winning Turbo Debugger. DS-186 provides 1M-byte of zero-wait state mapped memory. Memory can be mapped in boundaries of 1 KByte. The system operates up to 30 MHz. Emulation speed is limited by the maximum frequency of the microprocessor placed on the adapter. DS-186 has the ability to set 1M hardware breakpoints. The program is executed until a specified breakpoint condition is reached. Breakpoints are qualified by instruction fetch, instruction execution, data contents, read/write from/to memory and I/O. The Trace Buffer records 8K frames. The Trace display shows the source, assembler and bus cycles. DS-186 accepts Intel OMF-86 and EXE files. These files are converted by DS-186 utilities to absolute executable format.

FEATURES

- Support for 80C186/8/XL/EA/EB/EC, V40/50, 8086/8.
- Full Speed Emulation up to 30MHz.
- 1 MBytes of Zero Wait-State Mapped Memory.
- 8K Frames Dynamic Trace Buffer.
- 1M Qualified Hardware Breakpoints.
- 115 KBaud RS-232C Communication Link.
- Paradigm DEBUG and LOCATE Software.
- Support for Borland, Microsoft and Intel Compilers.
- Full C, Pascal and Assembler Expression Evaluation.
- Full Support for C++.

Assembler and High-Level-Language files are supported by DS-186: Borland C++, Turbo C++, Turbo C, Microsoft C, Microsoft C++, Intel C-86, Intel PLM-86 and more. DS-186 also accepts files generated by Turbo Assembler, Microsoft Assembler and ASM86. The system uses standard microprocessors for hardware and software emulation. The selection of a different microprcessor is made by replacing the microprocessor in the adapter or changing the adapter. The system runs at the frequency of the crystal on the adapter or from the clock source supplied by the user hardware.

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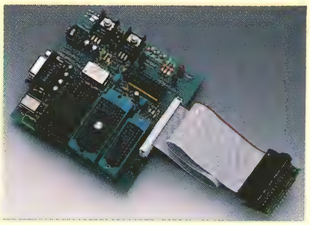
DS-51 - Microprocessor Development System

Ceibo DS-51 is a real-time in-circuit emulator dedicated to the 8051 family of microcontrollers. It is serially linked to an IBM PC or compatible host and carries out a transparent emulation on the target microcontroller. DS-51 supports the new low-power and low-voltage 8051 microcontrollers and derivatives. The system can emulate the microcontrollers using either the built-in 5V power supply or any voltage applied to the target circuitry. This selection is done by means of software control. The permitted voltage range is from 1.5V to 6V or higher. DS-51 emulates almost every 8051 derivative in the complete voltage and frequency range specified by the microcontroller manufacturer. The minimum frequency is determined by the emulated chip characteristics, while maximum frequency is up to 40MHz. The software includes Source Level Debugger for PLM and C, Assembler Debugger, Performance Analyzer, On-line Assembler and Disassembler, Conditional Breakpoints and many other features. DS-51 accepts files generated by the most common 8051 Assemblers and High-Level Language Compilers. Standard systems are supplied with 128KBytes of Internal Memory, 64K Hardware Breakpoints, 32K Real-Time Trace Memory and Logic Analyzer with external testpoints, and Personality Probe supporting most of the 40-Pin DIP or 44-Pin PLCC/QFP microcontrollers. The supported microcontrollers are: 8031/2, 80C31/2, 80CL31/2, 8051/2, 80C51/2, 87C51/2, 8XCL51, 8XC51FA/FB, 8XCL410, 80C515, 80C517, 8XC524, 8XC528, 80C535, 80C537, 8XC550, 8XC552, 8XCE558/9, 8XC562, 8XC575, 8XCL580, 8XC592/8, 8XC652, 8XC654, 8XC750/1/2, 8XCL782, 8XC851 and others.

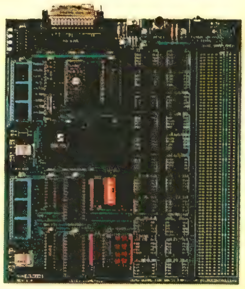
Development Tools

Ceibo offers a broad line of dedicated Development Tools for emulating different Microcontrollers and including all the necessary elements to design and debug your embedded system. Among these tools are DB-501, DS-750 and DS-752.



DB-51 Development Board

Ceibo/Philips DB-51 is a system design board dedicated to the 80C51 microcontrollers and derivatives. The software supplied with DB-51 includes Source Level Debugger for Assembler, PLM and C, Performance Analyzer, On-line Assembler and Disassembler, Software Trace, Conditional Breakpoints and many other features. DB-51 provides 32K of user code memory and has a special wire-wrap area for prototyping.



MP-51 - Programmer

Ceibo MP-51 is a high-quality Microcontroller, Flash Memory, EPROM and PLD Programmer dedicated to all the microcontrollers belonging to the 8051 family, 24 to 32-pin EPROMs, high-density PLDs and PSD devices. MP-51 allows to enable or disable the PLD or Microcontroller security capabilities and handles Lock Bits and Encryption Table available in several Microcontrollers. MP-51 loads different file formats: Intel Hex, Intel OMF, Binary, Motorola S-records, etc. Adapters are available for all the possible packages, such as DIP, LCC, PLCC, SO, and QFP.

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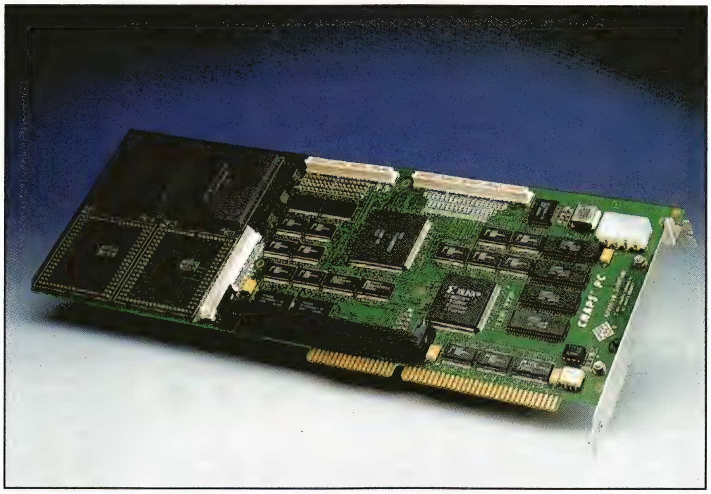
CIRCLE NO. 10

Massively parallel PC board performs pattern recognition



The massively parallel CNAPS/PC board performs as many as 2.56 billion multiply/accumulate operations/sec.

A new PC plug-in board, containing as many as 128 processors, performs pattern-recognition tasks 1000 times faster than even a Pentium-based computer. Adaptive Solutions Inc's massively parallel CNAPSPC board uses one or two chips that each contain 16 or 64 processors for DSP applications. With two 64-processor chips, the board performs 2.56 billion multiply/accumulate operations/ sec.

The CNAPS/PC board works as a coprocessor for high-speed parallel operations, leaving the system CPU available for other tasks. The processor chips, also from Adaptive Solutions, are for single-instruction, multiple-data (SIMD) execution. Each of the 16 or 64 processors on a chip is a complete DSP with its own on-chip memory. The combination of parallel operation and local memory enables the processing of a large set of data in a single clock cycle. Data moves through an external port at 80 Mbytes/sec.

Prices for CNAPS/PC range from $2995 for a 16-processor board to $6995 for a 128-processor version. VME versions and software-development systems are also available.**—Gary Legg**

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Circle No. 418

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Tantamount® Designs (Molded)	293D, 893D	.10 - 330µF	Standard and fused CWR11 MIL-C-55365/8

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CIRCLE NO. 72

Low-cost controller drives small LCDs. The CDS-PC55 LCD-controller board provides a low-cost ISA-bus interface to graphics LCDs with smaller display formats than VGA. Although it generates 640×480-pixel displays, it can also produce displays as small as 128×64 pixels, making it useful for applications that don't require VGA capability. It provides duty cycles from 1/32 to 1/240 and has 1-bit serial, 2-bit parallel, and 4-bit parallel LCD interfaces. $190 (1); $98 (100). **Apollo Display Technologies Inc**, Holtsville, NY. (516) 654-1143. **Circle No. 396**

Half-size PC cards hold full-featured computers. The Viper single-board computers use double-sided surface-mount assembly to pack lots of features on a 4.8×7.1-in. half-size PC add-in card. Each 386SX- or 486SLC-based card can accommodate 16 Mbytes of DRAM, 1 Mbyte of SRAM, and 1 Mbyte of flash memory. The boards also provide IDE and SCSI support and have a local-bus SVGA to drive CRTs or flat-panel displays. Other features include a PC/104 expansion header and keyboard and floppy-disk controllers. Viper 800 (386SX and CRT SVGA), $945; Viper 801 (386SX and flat-panel support), $1045. **Teknor Microsystems Inc**, Montreal, PQ, Canada. (514) 437-5682. **Circle No. 397**

EL displays have low EMI. The EL640 family of electroluminescent displays substantially reduces generated EMI via filters on all signal-input lines, redesigned etched-circuit boards, and improved shielding. They meet CISPR-B and VDE-B (European) and FCC-B (US) requirements. From $650 to $1510 (100). **Planar Systems Inc**, Beaverton, OR. (503) 690-1100. **Circle No. 398**

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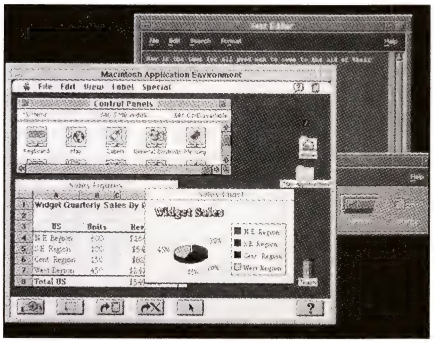
Rugged, solid-state memory cartridge holds up to 40 Mbytes. The Series 2 removable memory cartridges work in environments that are too rugged for Personal Computer Memory Card International Association cards or disk drives. The 5-, 10-, 20-, and 40-Mbyte flash-memory cartridges emulate IDE hard-disk drives and fit into a holder that installs in a 3.5-in. floppy-disk-drive bay. 5-Mbyte cartridge, $995; IDE interface holder, $595. **Targa Electronics Systems Inc**, San Ramon, CA. (510) 277-0188. **Circle No. 399**

SPARC II-based board lets PCs run Unix. The InBoardEngine/MS2, a PC/AT board with a MicroSPARC II processor, lets DOS, Windows, and OS/2 users run workstation applications. With a 70-MHz processor, it achieves 51 SPECint92 and 43 SPECfp92 performance. The board includes all standard workstation interfaces, including Ethernet; SCSI; SBus; and serial, parallel, and audio ports. $4995. **Opus Systems**, Santa Clara, CA. (408) 562-9340. **Circle No. 400**

PC/104 controller drives flat-panel displays. The MiniModule/VGA-FP, a flat-panel video controller, puts high-resolution images on a variety of color and monochrome LCDs. The 16-bit, PC/104-format module is compatible with VESA, VGA, EGA, CGA, MDA, and Hercules standards. It displays up to 256 colors or gray scales and provides a maximum resolution of 1024×768 pixels. $255 (100). **Ampro Computers Inc**, Sunnyvale, CA. (408) 522-2100. **Circle No. 401**

RAID systems work on the desktop. The Mega Drive Power Array family of desktop redundant-array-of-inexpensive-disk (RAID) systems comprises modular docking stations and shock-mounted, removable disk drives. They include Fast SCSI-2 and duplexed Fast SCSI-2 interfaces for data transfer at 10 and 20 Mbytes/sec. They can implement RAID levels 0, 1, and 5. Capacity ranges from 535 Mbytes to more than 8 Gbytes. From $2899. **Mega Drive Systems Inc**, Beverly Hills, CA. (310) 247-0006. **Circle No. 402**

RAID controllers work on ISA and EISA buses. The GDT2000 and GDT3000 families of redundant-array-of-inexpensive-disk (RAID) controllers work on the ISA and EISA buses, respectively, to implement RAID levels 0 and 1. Controller firmware allows the additional implementation of levels 4 and 5. The controllers come with one, two, or five Fast SCSI channels. Prices vary from DM550 to DM5280, depending on bus type and number of channels. **Vortex Computersysteme GmbH**, Flein, Germany. 49 (0) 7131-5972-0 **Circle No. 403**



Software runs Macintosh programs on workstations. The Macintosh Application Environment (MAE) brings the ease-of-use features of the Macintosh operating system to Sun and Hewlett-Packard workstations. The software links the Macintosh and Unix operating systems, allowing most Macintosh application programs to run on Unix-based SPARCstations and HP 9000 Series 700 systems. $549. **Apple Computer Inc**, Cupertino, CA. (408) 996-1010. **Circle No. 404**

CD-ROM drive connects to motherboard or IDE. The CM207 CD-ROM drive supports the Integrated Drive Electronics (IDE)/AT attached packet interface (ATAPI) protocol, allowing direct connection to the motherboard of new PCs. An IDE adapter card provides the connection for existing PCs. The drive provides double-speed data transfer and a 32-msec access time. $199. **Philips LMS**, Colorado Springs, CO. (719) 593-4185. **Circle No. 405**

Hard disk holds 4 Gbytes. The Grand Prix 4280 and 2140 3.5-in. hard-disk drives provide 4 and 2 Gbytes, respectively, of data storage. With 7200-rpm rotational speed and an internal data rate of 9.7 Mbytes/sec. The drives achieve their speed using the vendor's partial-response/maximum-likeli-

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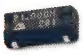

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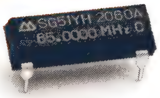

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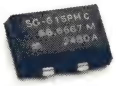

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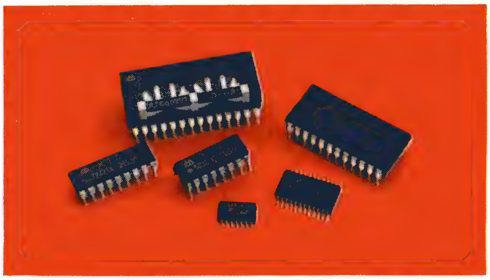
RTC-659X 8 bit parallel bus, 114 bytes SRAM, alarm, battery holder.



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CIRCLE NO. 121

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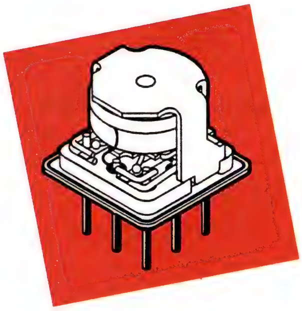

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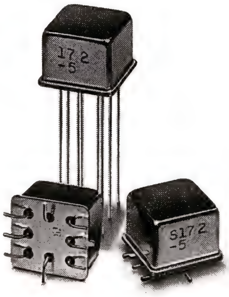

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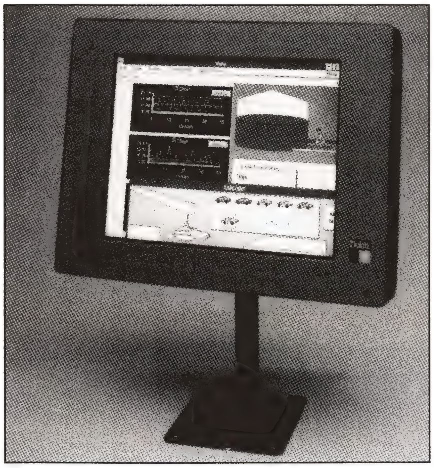
CIRCLE NO. 204

hood read channel. 4280, $2500; 2140, $1650. **Quantum Corp**, Milpitas, CA. (408) 894-4000. **Circle No. 406**

Caching controller provides fast I/O. The CSA-6300 VESA (Video Electronics Standards Association) local (VL)-bus-to-SCSI caching controller provides fast I/O for most 486- and Pentium-based computers. The controller's "Tag" RAM architecture offloads the main processor, resulting in maximum controller efficiency and reduced CPU overhead. The device is expandable to 64 Mbytes of memory. $599. **CMD Technology Inc**, Irvine, CA. (714) 454-0800. **Circle No. 407**



Flat-panel display family has 14-in. model. The DataView series of industrial displays includes models with 8.4- to 14-in. diagonal measurements. Units are available in monochrome and in very bright, high-contrast versions. The displays can work as stand-alone monitors or, with a special video controller, up to 100 ft from a connected computer. Prices for monochrome models start at $1900; color models, from $2900. **Dolch Computer Systems**, Milpitas, CA. (408) 957-6575. **Circle No. 408**

Device adds serial I/O to commercial software. The Software Wedge adds 2-way serial I/O to any DOS, Windows, OS/2, or NT application program. It works by converting incoming serial data to keystrokes, so data seems to be typed. The Windows version supports Dynamic Data Exchange, so you can place serial input and output buffers directly in Windows and OS/2 applications. DOS version, $295; Windows version, $395. **TAL Enterprises**, Philadelphia, PA. (215) 763-2620. **Circle No. 409**

I/O board performs signal processing. The Sig32C-8, a 7.5-in. PC plug-in board, combines the AT&T DSP32C 32-bit floating-point DSP with eight channels of analog I/O. Each channel contains 16-bit sigma-delta A/D and D/A converters and programmable input gain, output attenuation, and sampling rate. The sigma-delta technology gives each channel automatic antialiasing and reconstruction filters. With software, $3995. **Signalogic**, Dallas, TX. (214) 343-0069. **Circle No. 410**

Credit-card-sized computer costs $200. The Cardio-86 packs an x86-based motherboard into a credit-card-sized package. System interface is via a 236-pin connector on the side. The system includes industry-standard features, such as keyboard and VGA controllers. $202 (1000). **S-MOS Systems**, San Jose, CA. (800) 228-3964. **Circle No. 411**

PCMCIA card drive connects to SCSI. The MCDISK-E Personal Computer Memory Card International Association (PCMCIA)-compatible memory-card drive connects to any PC, workstation, or VME system via a SCSI port. The unit is an open-frame, 3.5-in. form-factor drive for OEM applications. It accepts SRAM, flash, and one-time-programmable memory cards. It has two PCMCIA slots that can accept two thin cards (PCMCIA Type I or II) or one thick card (PCMCIA Type III or the unofficial Type IV). $395. **Gespac Inc**, Mesa, AZ. (602) 962-5559. **Circle No. 412**

DSP board stacks on PC/104 bus. The PC5-DO DSP board for the PC/104 bus has a 50-MHz DSP32C processor, 512 kbytes of zero-wait-state SRAM, and an 8- or a 16-bit PC/104 interface. It also has a 25-Mbps serial port and a 32-bit, 100-Mbyte/sec interface for mezzanine expansion. Various modules that add capabilities for data acquisition and audio are optional. $1395. **Communication Automation and Control Inc**, Allentown, PA. (800) 367-6735. **Circle No. 413**

PC software displays Unix images. XoftWare/32 for Windows, with XIE option, turns PCs into low-cost image-display stations for Unix-based applications. It implements the recently released X Image Extension (XIEv5.0) imaging standard for Unix. XoftWare/32 is 32-bit PC X-server software that allows concurrent access and display of Windows and network-based Unix applications on one screen. $595. **AGE Logic Inc**, San Diego, CA. (619) 455-8600. **Circle No. 414**

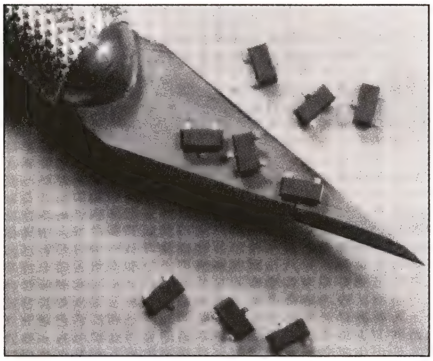
PCMCIA card drives fit PCs. The CardSharkII, a 3.5-in. form-factor Personal Computer Memory Card International Association (PCMCIA) card drive, comes in internal and external models for PCs. It supports all types of PCMCIA cards, including memory cards, I/O cards, and hard-disk drives. It accepts two Type I or Type II cards or one Type III card. Internal version, $299; external version, $349. **Curtis Inc**, St Paul, MN. (612) 631-9512. **Circle No. 415**

Device sends video to multiple monitors. VideoShare accepts VGA output from one to four PCs and displays the data simultaneously on two to 16 monitors as much as 300 ft away. The PCs that provide the VGA output can be as much as 50 ft away. The product is available for different numbers of PCs and displays. Prices vary accordingly, from $265 to $1195. **Raritan Computer Inc**, Belle Mead, NJ. (908) 874-4072. **Circle No. 416**

Power saver turns off computer monitor. Green Keeper, a module that attaches between a PC and its keyboard, saves electricity by turning off the PC's monitor when the PC isn't being used. It doesn't just blank the screen; it actually turns off power. Typing any key turns power back on. You can program nine inactivity intervals, each for a different time of day. $69.95. **B&B Electronics**, Ottawa, IL. (815) 434-0846. **Circle No. 417**

COMPONENTS

MOVs absorb up to 120V. Four members of the C-Series III MOV family shrug off continuous rms operating voltages of 230, 250, 275, and 300. The MOVs shunt transient currents of 6000A for 8 µsec and 9000A for 20 µsec (14- and 20-mm devices, respectively), exceeding UL 1449 requirements. The units can withstand 10 such overload pulses before failing. $0.60 (14 mm) and $0.70 (20 mm) (10,000). **Harris Semiconductor,** Melbourne, FL. (800) 442-7747, ext 7205. **Circle No. 541**



Zener diodes come in surface-mount package. The RSZ5200 series of Zener diodes comes in the SOT-23 package. Zener voltages range from 2.5 to 51V, and power dissipation is 225 mW. The devices' operating range is –55 to +150°C. $0.04 (1 million). **Rohm Corp,** Antioch, TN. (615) 641-2020, ext 134. **Circle No. 542**

RF power modules transmit 45W. Two rf power modules for vehicle-mounted, 2-way, mobile FM transceivers provide 21.0-dB gain min and 40% efficiency min. The M67781l covers 135 to 160 MHz, and the M67781H covers 150 to 175 MHz. Both operate from 12.5V supplies. $58 (1000). **Mitsubishi Electronic Device Group,** Sunnyvale, CA. (408) 730-5900, ext 2106. **Circle No. 543**

PIN photodiodes available in several package styles. The OP900 series of PIN photodiodes are available in lateral-mounting, axial-mounting, and ambient-light-filtering packages. $0.39 to $0.46 (10,000). **Optek Technology Inc,** Carrolton, TX. (214) 323-2200. **Circle No. 544**

Full-wave rectifiers have tiny footprints. The Series PZS full-wave bridge rectifiers measure 4×4.7×2.5 mm with 1.5×0.6-mm solder pads. The bridges are available in 200 or 600V peak-reverse voltage ratings. Forward current specs are 0.8A continuously, 30A surge. Samples available. $0.35 (1000). **Electronic Devices Inc,** Yonkers, NY. (914) 965-4400. **Circle No. 545**

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Low on-resistance, surface-mount SO-8 MOSFETs suit 3.3 or 5V systems. The dual n-channel Si9925DY exhibits an 80-mΩ on resistance at the 2.5V end-of-charge voltage of a lithium-ion cell. The Si9928DY has complementary n- and p-channel transistors (60 and 130 mΩ, respectively, at 4.5V). The single p-channel Si94934DY offers a 40-mΩ on-resistance at 4.5V and a 1-µA max drain-to-source leakage current. Si9925DY: $1.14, Si943DY: $1.25, Si9928DY: $1.19 (100,000); delivery eight weeks. **Siliconix,** Santa Clara, CA. (408) 988-9000. **Circle No. 546**

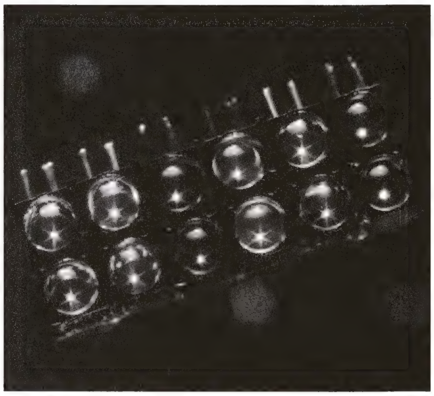
PCMCIA crystal is low rider. The ECCM1 series of surface-mount crystals have a maximum height of 1.3 mm. The units have a ceramic body. Standard frequencies range from 11.0592 to 40 MHz. The crystals meet Types 2 and 3 PCMCIA specs. Frequency accuracy is ±50 ppm, and stability is ±100 ppm (time period unspecified). $2.20. **Ecliptek Corp,** Costa Mesa, CA. (714) 433-1200. **Circle No. 547**

IGBT modules provide high power rating. The CM150TF-12H, CM75TF-24H, and CM100TF-24H 6-in-1-package IGBT modules have 75 or 100A continuous collect-current ratings for 1200V modules and 150A for 600V modules. The modules can operate at switching frequencies above the audible range. CM150TF-12H: $262.15, CM100TF-24H: $359.89 (10). **Powerex,** Youngwood, PA. (412) 925-4488. **Circle No. 548**

N-channel small-signal MOSFET comes from second source. The 2N7002 device comes in a SOT-23 case, has a $r_{DS(ON)}$ of 7.5Ω at 0.5V and a 60V min breakdown voltage. $0.176 (3000). **Central Semiconductor Corp,** Hauppauge, NY. (516) 435-1110. **Circle No. 549**

SAW filters clean up digital radiotelephone communications. The SF1051 110.592-MHz center-frequency surface-acoustic-wave (SAW) filter suits DECT and wireless LAN applications. It has a 10-dB max insertion loss and a 1.152-MHz 3-dB bandwidth. In-band group-delay deviation is <200 nsec p-p. Its hermetic package measures 13.3×6.5×2 mm. The SF1052 71-MHz center-frequency SAW filter suits GSM base-station applications. Its insertion loss is 8 dB max, and its 3-dB bandwidth is 300 kHz min. In-band group delay deviation is <300 nsec p-p. The unit comes in a 14-pin hermetic metal DIP. SF1051: $25, SF1052: $30 (100). **RF Monolithics,** Dallas, TX. (214) 233-2903. **Circle No. 550**

High-density MOSFET family proliferates. The SSD2005, 2007, 2009, and 21023 are single, dual, and complementary n-channel and p-channel, low-power MOSFET switches packaged in an 8-pin surface-mount, SOT case. Models exhibit 4.5 and 10V turn-on voltages. 2007 $1.20 and 2009 $1.50 (1000s). **Samsung Semiconductor,** San Jose, CA. (408) 446-2760. **Circle No. 551**



Precisely focused circuit-board LEDs eliminate light bleeding into adjacent areas. Precisely focused LEDs come in single- or bi-level packages. Case styles include clear cases for back-lighting legends and diffused for direct viewing through a window or an aperture. The LEDs come in five colors from 66-nm ultra-bright red through 470-nm blue. Also available are special-purpose LEDs, such as high-efficiency, low-current (2-mA); bicolor (dual emitters); infrared; and flashing. A 3000-mcd, 590-nm yellow LED is visible in sunlight. A 2-LED package can display four colors from a single location. Samples available. $1 (1000). **Ledtronics Inc,** Torrance, CA. (310) 534-1505. **Circle No. 552**

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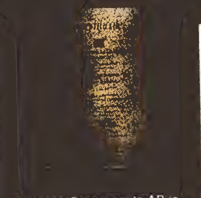

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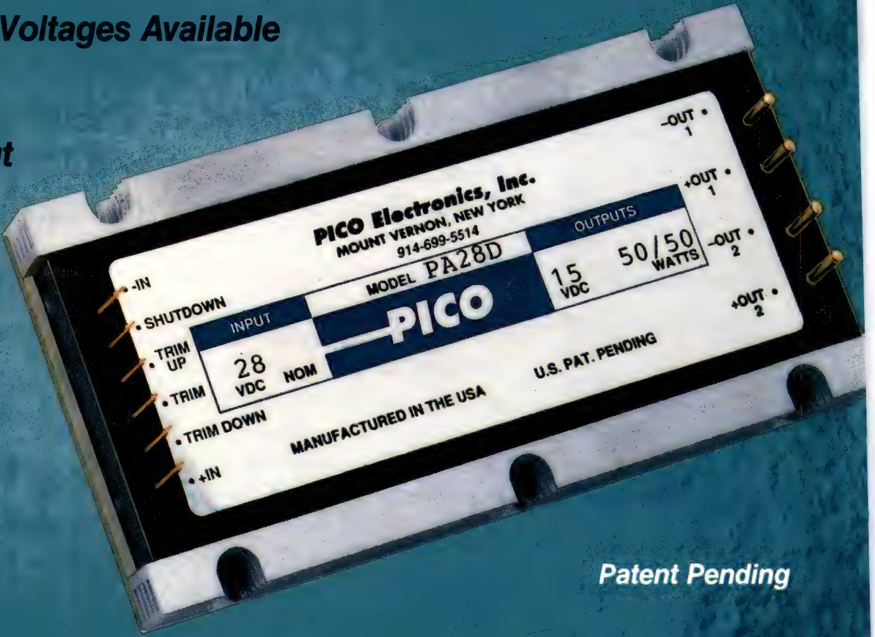

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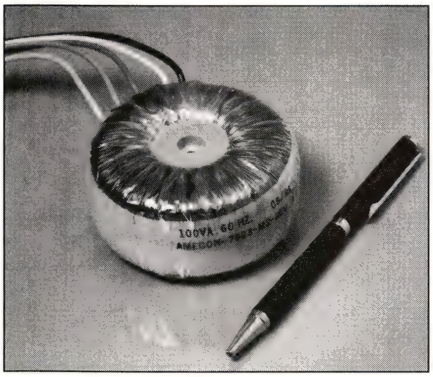
CIRCLE NO. 190

COMPONENTS

MS Windows program monitors GE Fanuc PowerTRAC devices. PowerLOG is an MS Windows 3.1 program that shows a real-time display of the performance of GE Fanuc PowerTRAC devices. Quantities displayed include voltage, current, active, and reactive power, power factor, and harmonic VAR. $4500. **TA Engineering**, Morage, CA. (510) 376-8500. **Circle No. 553**

Power MOSFETs have enhanced voltage-blocking capability. A family of power MOSFETs have multiple rings that shape the field toward the edges of the die, enhancing the voltage blocking of these high-voltage devices. Available in 1000 and 800V devices, the MOSFETs handle 4 to 10A and cost from $3.90 to $21 (1000), delivery; 10 weeks. **Motorola Inc**, Phoenix, AZ. (602) 244-3576. **Circle No. 554**

Optical-interconnect modules provide 200-Mbps/channel for $100/channel. A 10-channel, single-mode fiber-optic interconnection subsystem permits reliable board-to-board data transmission at 200 Mbps/channel over distances of 400m. An array of single-mode optical fibers connects the MCS2101 transmitter to the MCR2101 receiver. Skew is 2 nsec max for a 400m cable. The modules measure 3×0.75×0.60 cm and require a single –3.3V supply. $1000/pair (50,000 pairs). **Hitachi America**, Brisbane, CA. (800) 285-1601, ext 06. **Circle No. 555**



Toroidal power transformers optimize efficiency and power-to-weight ratios. The Toro transformer line has power ratings from 10 VA to 8 kVA. A 100-VA model weighs 1.9 lbs and has an efficiency rating of 86%. The transformers are UL1411-listed. The units have a self-contained mounting scheme that eliminates external brackets. $12 (OEM quantities); delivery four to six weeks. **Amecon Inc**, Anaheim, CA. (714) 634-2220. **Circle No. 556**

Packaged LED is sunlight-visible. The model DDP 200-A3K packaged LED comes in panel-mount and pc-board configurations. The 594-nm LED's luminous intensity is 3000 mcd. Working voltages are 5 to 220V. $2.66 (1000), delivery four to six weeks. **Data Display Products**, El Segundo, CA. (310) 640-0442. **Circle No. 557**

T-1 sized, right-angle LED is small. The series 5325F is a T-1 sized, right-angle LED indicator whose pc-board footprint measures 0.15×0.22 in. You can stack the units side-by-side on 0.150-in. centers. The indicator comes with a range of LEDs from 8.5 to 80 mcd at 20 mA in red, amber, green, and yellow. 2-mA versions are also available. The indicator's body meets UL940-V-2, has pretrimmed leads, and pc-board standoffs. $0.29 (5000). **Industrial Devices Inc**, Hackensack, NJ. (201) 489-8989. **Circle No. 558**

Telecom transformers suit V.32 applications. The SPT-022 and SPT-023 telecom transformers match 600Ω primary and secondary impedances at 0A-dc loop currents. Total harmonic distortion is –76 dB for the SPT-022 and –82 dB for the SPT-023 (measured at –10 dBm, 600 Hz). The devices measure 1.024×0.945×0.472 in. SPT-022 and R2.70 SPT-023, $2.25 (5000). **Prem Magnetics Inc**, McHenry, IL. (815) 385-2700. **Circle No. 559**

Rise time filters slow input signals. Rise time filters have a Gaussian response that slows the rise time of an input signal. The filters' time-domain step responses have no overshoot or ringing and settle rapidly to the final value. The filters match 50Ω sources. $65 to $250. **Picosecond Pulse Labs Inc**, Boulder, CO. (303) 443-1249. **Circle No. 560**

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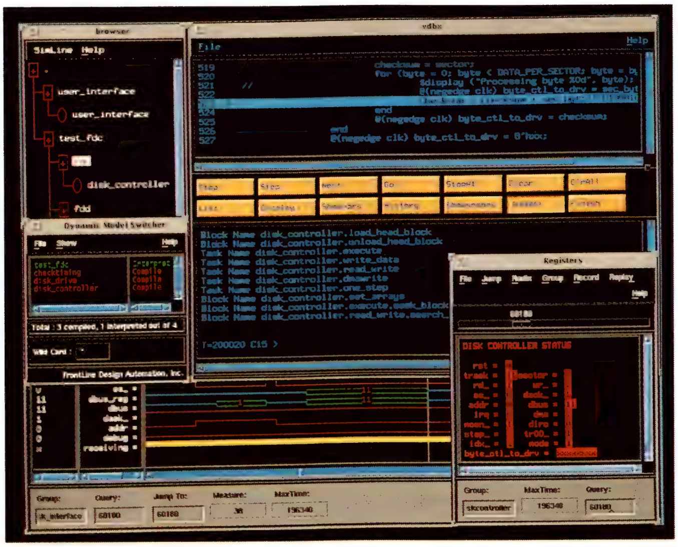
CIRCLE NO. 187

Verilog simulator offers compiled speed with interpreter flexibility



```
519                                     checksum = sector;
520                                     for (byte = 0; byte < DATA_PER_SECTOR; byte = by
521      //                                     $display ("Processing byte %0d", byte);
522                                             @(negedge clk) byte_ctl_to_drv = sec_byt
524                                     end
525                                     @(negedge clk) byte_ctl_to_drv = checksum;
526                             end
527                             @(negedge clk) byte_ctl_to_drv = 8'hxx;
```

```
Block Name disk_controller.load_head_block
Block Name disk_controller.unload_head_block
Task Name disk_controller.execute
Task Name disk_controller.write_data
Task Name disk_controller.read_write
Task Name disk_controller.dmawrite
Task Name disk_controller.one_step
Block Name disk_controller.set_arrays
Block Name disk_controller.execute.seek_block
Block Name disk_controller.read_write.search_

T=200020 C15 >
```

The SimLine Verilog simulator from FrontLine design lets you select compiled, interpreted, and XL simulation engines on a module-by-module basis.

The SimLine Verilog simulator combines three simulation engines in one simulator. A compiled engine offers fast execution—the company claims 10 to 30× what you get from interpreted Verilog simulators. Although compiled simulators offer execution speed, they also require a long compile time. For fast turnaround while debugging a design, interpreted simulators eliminate the compile-time penalty at the cost of slower execution. With other Verilog simulators, you are forced to choose between the two. The simulator provides a dynamic model-switching capability that lets you select on a module-by-module basis which simulation engine you'll use.

Instead of using a backplane synchronization commonly used by other simulation companies to synchronize the multiple simulation engines, the software uses a single executable process called DriveLine to perform the synchronization. According to the company, the single-executable process requires lower overhead than simulation backplanes, providing faster simulation.

For most design work you can use the interpreted engine for the module you are developing and use the compile engine for modules that are complete or won't be modified during the current simulation session. This approach provides greater efficiency in getting your design debugged. In addition, you can select a third XL engine that the company claims offers performance comparable to Cadence's Verilog XL, yet offers more accuracy.

The simulator is aimed at simulating the million-gate designs necessary for large designs using submicron technology. Because interconnect delays figure so prominently in designs below 0.5 μm, the simulator provides additional features for timing accuracy such as support for nonlinear delay models, and interconnects with multiple fanouts and multiple drivers. SimLine, which will be available in June, runs on Unix workstations and costs $27,500.

The company is also offering a second, lower-cost interpreter-based Verilog simulator call BaseLine that is targeted at FPGAs and smaller ASICs. Baseline is available now, runs on Windows-based PCs ($4995) and Unix workstations ($9995).—**Doug Conner**

FrontLine Design Automation, San Jose, CA. (408) 456-0222.

Circle No. 419

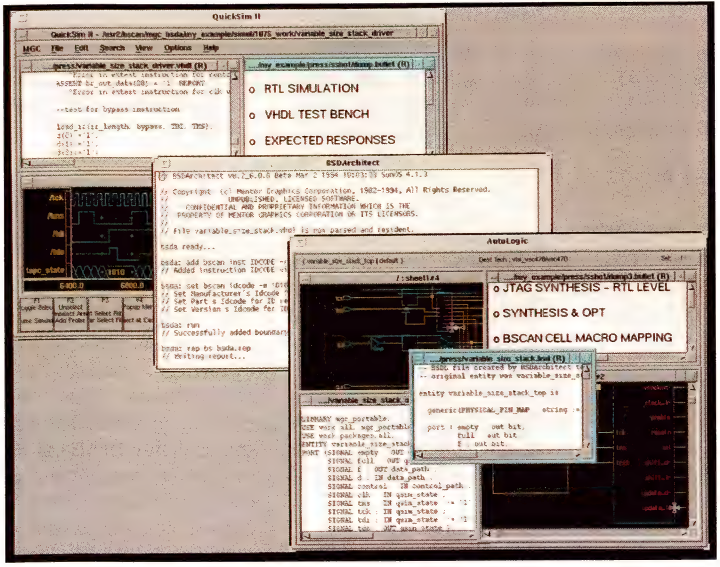
Automatically generate a VHDL description for boundary scan

BSDArchitect automatically generates a hierarchical VHDL (VHSIC Hardware Description Language) description for IEEE 1149.1 boundary scan and a description of the core logic. The tool is aimed at ASIC, IC, and multichip-module designs. You can specify additional instructions to the standard IEEE 1149.1, or create boundary-scan logic by using the industry-standard Boundary Scan Description Language (BSDL).

The tool also lets you retarget boundary-scan descriptions to other devices, independent of the ASIC vendor. The tool interfaces to third-party commercial VHDL simulation and synthesis tools. BSDArchitect will be available in the third quarter of 1994 and costs $25,000.—**Doug Conner**

Mentor Graphics, Wilsonville, OR. (503) 685-8000.

Circle No. 420



```
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BSDArchitect moves boundary-scan designs earlier in the top-down design process.

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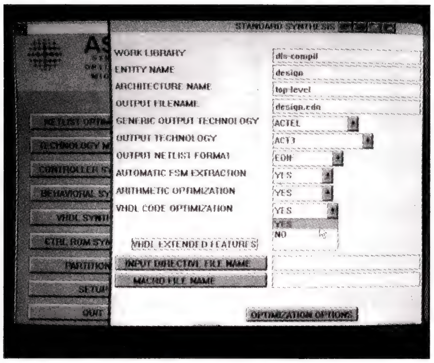
Finite element-analysis tool runs on PCs. The PDEase Finite element-analysis software lets you analyze a wide range of static and time-dependent physical models. The software automatically generates and refines element grids and adaptively selects time steps in time-dependent problems. The software runs on PCs and costs $499. **Macsyma Inc**, Arlington, MA. (617) 646-4550. **Circle No. 484**



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ARCHITECTURE NAME top-level
OUTPUT FILENAME design.edn
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OUTPUT TECHNOLOGY ACT1
OUTPUT NETLIST FORMAT EDIF
AUTOMATIC FSM EXTRACTION YES
ARITHMETIC OPTIMIZATION YES
VHDL CODE OPTIMIZATION YES

VHDL logic-synthesis system offers wide range of target devices. ASYL+ accepts VHDL, Palasm, and Open Abel inputs and synthesizes designs for PLDs, FPGAs, and ASICs. The software supports a variety of programmable-logic devices, including those from Actel, Altera, AMD, AT&T, Quicklogic, TI, and Xilinx. The tool also supports a variety of gate-array and standard-cell foundries. The ASYL+ synthesis engine and one library cost $2800 on a PC. A typical system includes VHDL support, multitechnology partitioning and targeting, and three device mappers and costs $15,500. **Innovative Synthesis Technologies**, Danville, CA. (510) 736-2302. **Circle No. 485**

Test-pattern generation tool verifies JTAG hardware. The AVLsim tool kit uses logic simulation to verify that JTAG hardware is designed to make the circuit scan testable. The tool automatically generates test vectors for chip- and board-level simulation environments. The AVLsim tool set costs $6000. **Alpine Image Systems Inc**, Los Altos, CA. (415) 941-3247. **Circle No. 486**

Windows-based Spice simulator offers 64-bit precision. Based on Berkeley Spice 3F2, the PROspice analog simulator comes with the PROtrace integrated waveform analyzer and support for analog modeling. The simulator comes as a stand-alone module or integrated with Viewlogic's other PRO Series electronic-design-automation products. PROspice costs $3995. **Viewlogic Systems Inc**, Marlboro, MA. (508) 480-0881. **Circle No. 487**

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Debug Verilog designs quickly. VirSim, a name derived from "virtual simulator", is a software tool for debugging Verilog designs quickly. The product appears to the user as an event-driven simulator for debugging. In actuality, it uses simulation results previously recorded from a Verilog simulator to move forward or backward in time. View multiple source or waveform windows simultaneously. VirSim costs $2000 for a floating network license. The source code window is an $800 option. **Simulation Technologies Corp**, New Brighton, MN. (612) 631-1858. **Circle No. 488**

Tool maps data-path elements into X-Blox modules. The X-Syn synthesis tool lets field-programmable-gate-array designers use VHDL or Verilog to directly target Xilinx's high-level X-Blox modules for the XC4000 family. X-Syn is an option to the Compass ASIC Navigator design tools and costs $15,000. **Compass Design Automation**, San Jose, CA. (408) 433-4880. **Circle No. 489**

Computational-fluid-dynamics software performs thermal analysis. The IcePak thermal-analysis tool provides a graphical user interface that provides models of standard objects, such as pc boards, fans, vents, openings, walls, plates, sources, and resistances. The tool also lets users create custom models by importing geometries from other sources. It generates a variety of graphical output data, including flow fields and color-coded temperature distributions. A software license costs $18,000/year. **Fluid Dynamics International**, Evanston, IL. (708) 491-0200. **Circle No. 490**

Native-code Verilog simulator cuts compiling time. Verilog Compiled Simulator (VCS) version 2.1 bypasses C compiling by directly generating

SHORTS

Quantic Laboratories now offers a revised Mentor Graphics interface. $6000. **Quantic Laboratories Inc**, (204) 942-4000. **Circle No. 491**

You can learn hardware-description-language (HDL) design methodologies using VHDL or Verilog. Classes range from one to four days and start at $300/student/day. **Widman Associates**, (408) 365-9924. **Circle No. 492**

SpiceAge*4W is an analog and mixed-signal simulator that runs under Windows and is compatible with Spice models. The software costs $895. **Tatum Labs Inc**, (313) 663-8810. **Circle No. 493**

Betasoft-Master performs integrated thermal analysis of electronic systems, pc boards, and components. The software runs on PCs under DOS or Windows and costs $12,480. **Dynamic Soft Analysis Inc**, (412) 683-0161. **Circle No. 494**

Hardware accelerator speeds VHDL simulation. The Paradigm ViP system accelerates VHDL simulations at the behavioral, register-transfer, or gate level. Depending on the configuration, the system performs simulations up to 70 times faster than workstation-based software simulators. Prices start at $79,000. **Zycad Corp**, (510) 623-4400. **Circle No. 495**

A software package, which runs under Windows, generates C code for state machines directly from state diagrams. $595. **R-Active**, (408) 252-2808. **Circle No. 496**

Fully functional Intel Pentium µP hardware models cost $8000; bus-functional behavioral models cost $15,000. **Logic Modeling**, (503) 690-6900. **Circle No. 497**

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Design Engineers Bulletin

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The Missing Link for M68HC16 / MC68302 Designs: QSPI Serial Nonvolatile Memories

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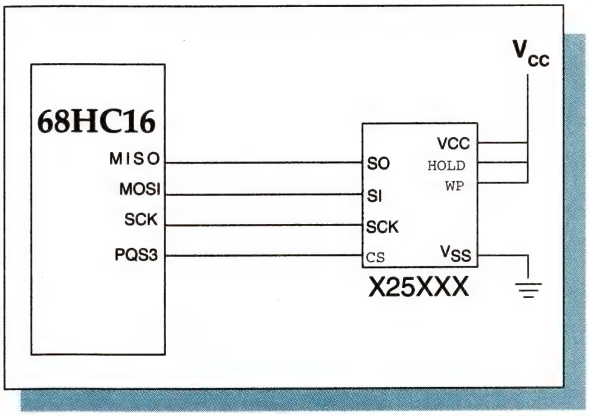
Xicor's Serial SPI memories are available as either Autostore™ NOVRAMS or E^2PROMS in densities from 256 Bits to 4K Bits with operating voltage ranges from 2.7 to 5.0 Volts.



X25XXX Family Interfaces Directly to M68HC16 QSPI Ports.

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In many applications, it is desirable to provide different levels of alterability to various parameters of data in the system. Certain data, such as calibration or configuration data should only be alterable during initial manufacture or service, while other data may be altered during system operation. This hierarchy of alterability was impossible to provide with older generation nonvolatile memories without resorting to the separation of the data into separate memory devices.

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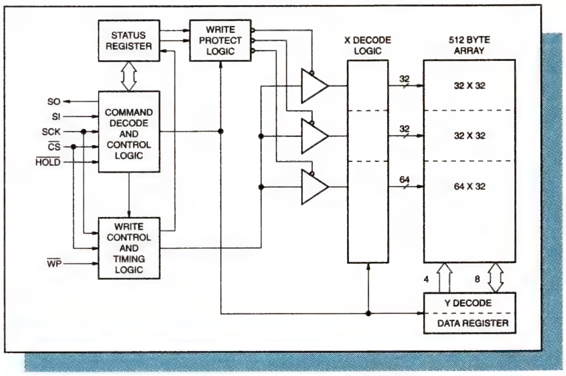

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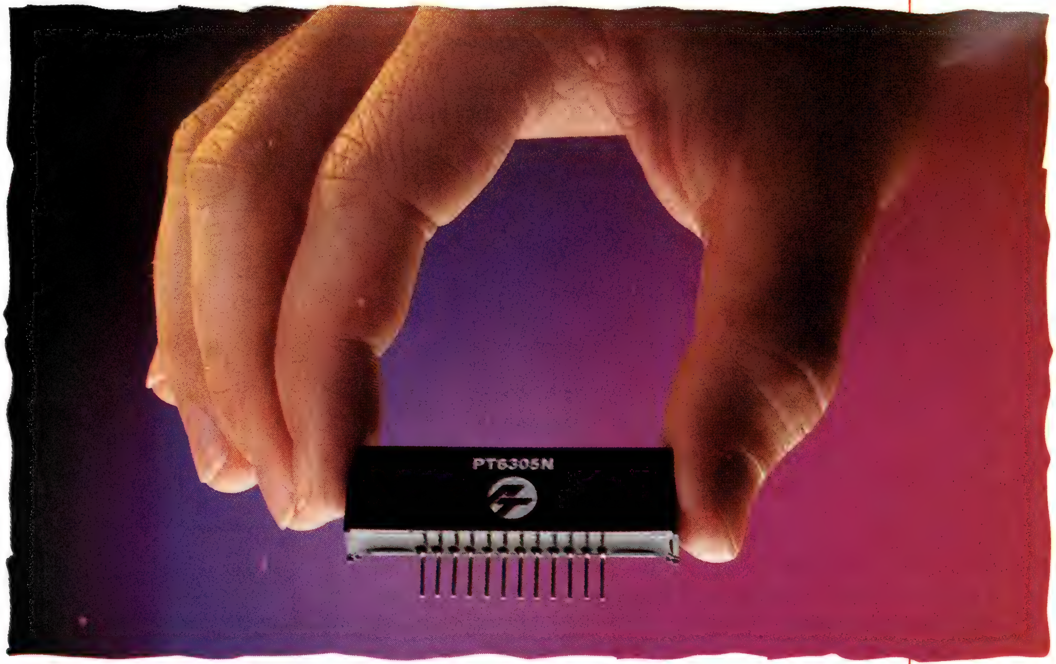

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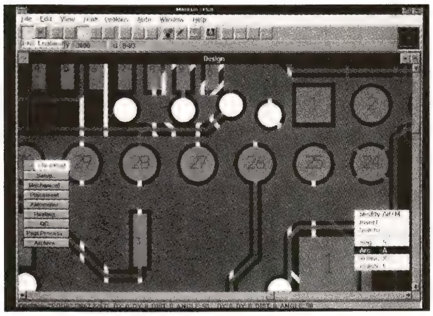
CIRCLE NO. 192

executable code. The simulator cuts the time to process a model for simulation to less than one-fourth that of the previous version. VCS 2.1 costs $45,000. **Chronologic Simulation**, Los Altos, CA. (415) 965-3312. **Circle No. 498**



Windows-based software offers complete schematic-capture and pc-board layout capability. Max-EDA 6.0 runs under Windows and Windows NT and includes schematic capture, automatic-test-point generation, forward and backward ECO automation, on-line design-rule checking, copper pour with automatic- thermal-relief generation, and a single-layer autorouter. The software costs $9950. **Massteck Ltd**, Littleton, MA. (508) 486-0197. **Circle No. 499**

Mixed-signal simulation interface links analog and Verilog simulation. A link between the Eldo analog circuit simulator and Chronologic Simulation's Verilog Compiled Simulator (VCS) lets users combine digital models written in Verilog with system-, analog behavioral-, and transistor-level descriptions within the same simulation environment. The Eldo-VCS interface costs $6000. **Anacad EES**, Milpitas, CA. (408) 954-0600. **Circle No. 500**

Project navigator speeds design of unfamiliar FPGAs. Each FPGA-device vendor requires particular files and a certain sequence of operations to complete an FPGA design. The Synario Project Navigator guides you through the steps in the proper sequence so you can concentrate on the logic design. The Project Navigator is part of the Synario Universal FPGA Design System for Windows and starts at $2995. **Data I/O**, Redmond, WA. (206) 881-6444. **Circle No. 501**

SHORTS & REVISIONS

PLDesigner-XL Version 3.2 adds support for Intel Flexlogic, Lattice pLSI and ispLSI, and AMD MACH 445 and 465 devices. The software also offers optional VHDL design entry. Prices start at $2995. **Minc Inc**, (719) 590-1155. **Circle No. 502**

HP Microwave Design System release 6.0 provides a library of more than 40,000 parts, an improved user interface, and new statistical-design software to improve production yields. Price ranges from $18,000 to $60,000. **HP-EEsof**, (800) 752-0900. **Circle No. 503**

PADS Perform now offers a cluster-placement option for simplifying parts placement on large pc boards. The software upgrade also includes increased via control for manufacturing and faster redraws under Microsoft Windows. $3495 to $17,000. **PADS Software Inc**, (508) 485-4300. **Circle No. 504**

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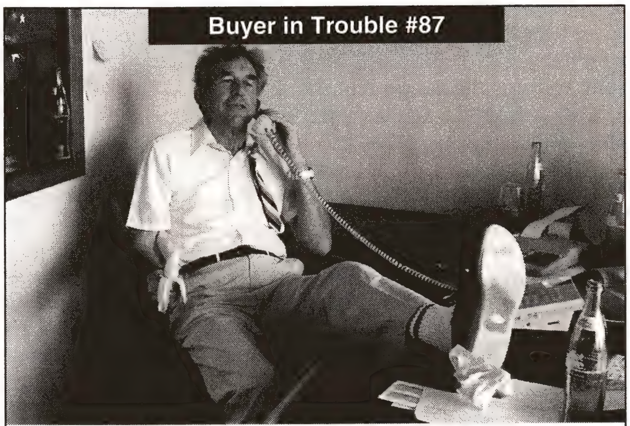

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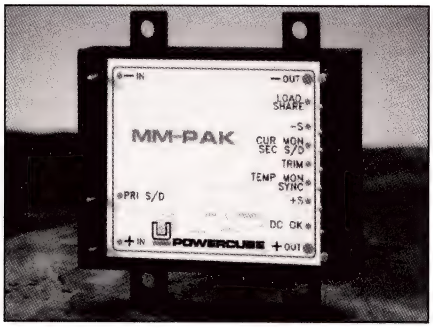

100W dc/dc converters have two shutdown pins. The MM-PAK 100W dc/dc converters measure 2.3×2.1×0.5 in. and have two remote-shutdown pins: one referenced to the input and one referenced to the output. Efficiency is 87% max. The units operate in parallel without external diodes. Output voltages include 2.1, 3.3, 5, 12, 15, 14, and 18V dc. Input voltage can range from 36 to 76V (48V dc nominal). $100 (100). **Powercube**, Billerica, MA. (508) 667-9500. **Circle No. 531**

5W converters operate from wide input range. The 500UR series of single- and dual-output 5W dc/dc converters operate from the 4:1 input-voltage ranges of 10 to 40V dc or 18 to 72V dc. Outputs are 5, 12, 15, ±5, ±12, or ±15V dc. Efficiency is 81% max, voltage accuracy specs ±1%, and input-output isolation is 500V dc. Line and load regulation are ±1%. The case size measures 1×2×0.375 in. Operating range without derating is –25 to +75°C. $48.30 to $51.89 (100). **Conversion Devices Inc**, Brockton, MA. (508) 559-0880. **Circle No. 532**

High-voltage supplies power gamma counters, spectroscopes, photon counters, pollution monitors, color scanners, and blood analyzers. The 4479 series of 0- to 2-kV, 2W high-voltage photomultiplier power supplies is available in output ranges from ±300V at 3 mA to ±2000V at 1 mA. Ripple is 2 mV typ, and line and load regulation are 50 ppm. The supplies measure 3.76×1.93×0.6 in. $279 (10); delivery, two to four weeks ARO. **International Power Sources Inc**, Ashland, MA. (508) 881-7434. **Circle No. 533**

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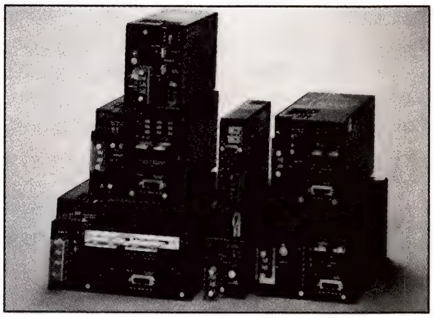
6W-dc/dc converters accept 3.5 to 16V battery input. The LV dc/dc-converter series' 4.5:1 input range takes the variable output voltage of batteries in stride. The supplies feature 700V isolation. Output noise is 50 mV p-p max. Output voltages are 5, 12, and 15V at 6W. Line and load regulation are 1% typ, and operating temperature is –40 to +85°C. $55.13 (100). **Calex Mfg Co Inc**, Concord, CA. (510) 687-4411. **Circle No. 535**

Low-leakage supplies meet strict medical safety requirements. A line of low-leakage medical switching supplies exhibits leakage currents of <30 μA. The supplies require no isolation transformers to meet international safety requirements. The customizable supplies come in three package sizes and three power levels from 40 to 130W. Units can have as many as five outputs. Model numbers are LL040, LL080, and LL120. Conducted EMI meets FCC and VDE 0871 class B. $40 to $225. **Adtech Power Inc**, Anaheim, CA. (714) 634-9211. **Circle No. 536**

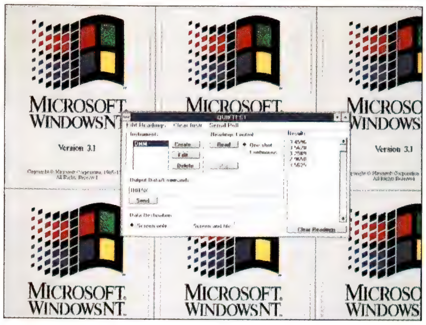
150W dc/dc converters have 2.4×4.6-in. footprints. The HD series of 150W dc/dc converters come in single-, dual-, and triple-output configurations. Input-voltage ranges are 18 to 36V, 20 to 60V, and 36 to 72V dc. The units provide 500V isolation. Output noise is 1% typ and the fixed switching frequency is 250 kHz. The units operate without derating to 85°C baseplate temperature. Singles, $122.20; duals, $137.35; triples, $146.95 in "OEM" quantities. **Wall Industries**, Exeter, NH. (603) 778-2300. **Circle No. 537**

Sponge-metal NiCd cells deliver 80% more juice than conventional NiCds. The SM80 ⅘A cylindrical NiCd P130ASJ cell has a 1.3-Ahr capacity. You can recharge the cell in on hour. $2.50 (1000s). **Panasonic Industrial Co**, Secaucus, NJ. (800) 848-3979. **Circle No. 538**



Power-supply family meets industrial challenges. The SE series of industrial power supplies withstands ac-line transients, elevated temperatures, shock, and vibration. The supplies can ride through a one-half-cycle dropout and withstand surges to 170V ac. The series meets IEC-801-2-3-4 and IEEE-587 category A3 as well as MIL-STD-810E requirements. The series comprises 22 models ranging from 50W to 1500W. $234. **Lambda Electronics**, Melville, NY. (516) 694-4200. **Circle No. 539**

Sealed lead-acid battery fits video tape recorders and cellular phones. The PS-1223 sealed lead-acid 12V battery has a 2.3-Ahr capacity. The unit measures 7.17×0.94×2.42 in. and weighs 1.76 lbs. The battery delivers 225 mA for 10 hours or 390 mA for 5 hours. You can recharge it 200 to 500 times depending on average depth of discharge. The battery is maintenance-free and operates in any position. $24.75 (500). **Power Sonic**, Redwood City, CA. (415) 364-5001. **Circle No. 540**



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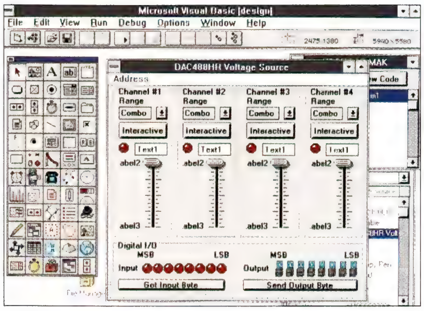

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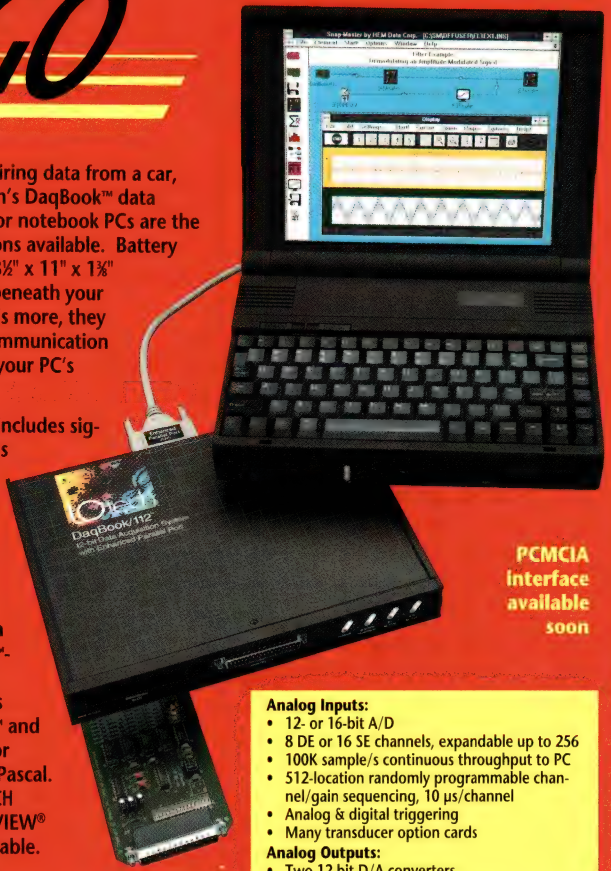

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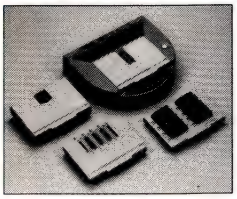

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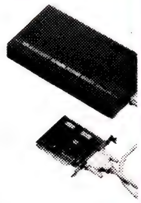

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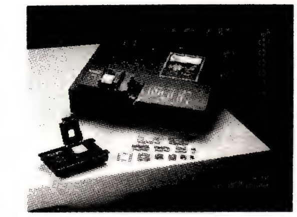

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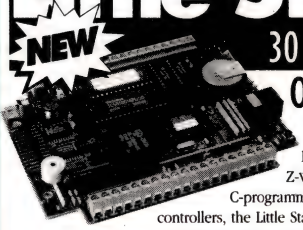

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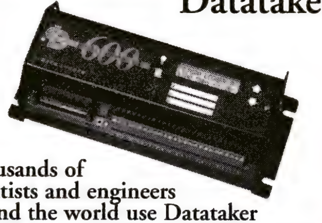

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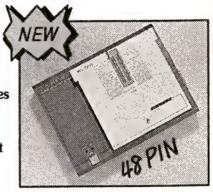

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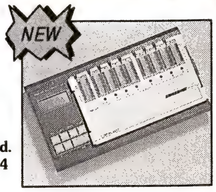

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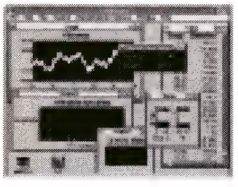

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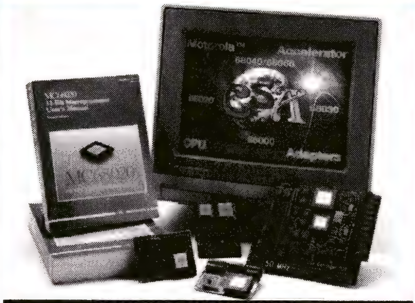

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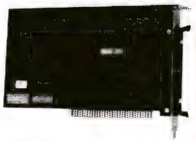

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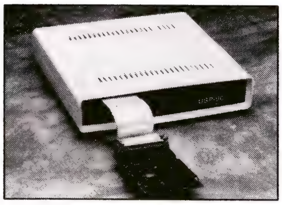

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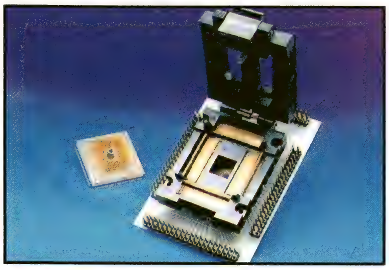

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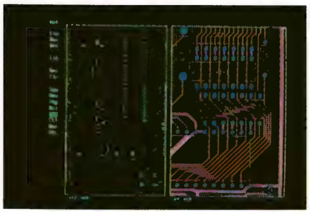

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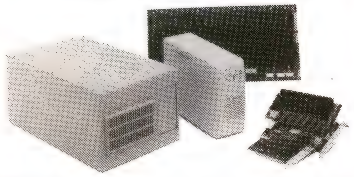

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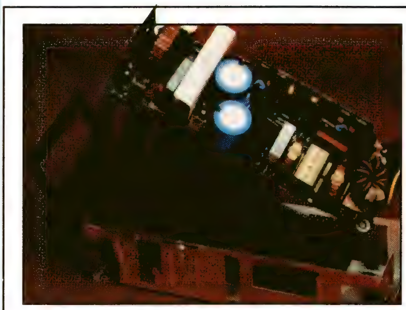

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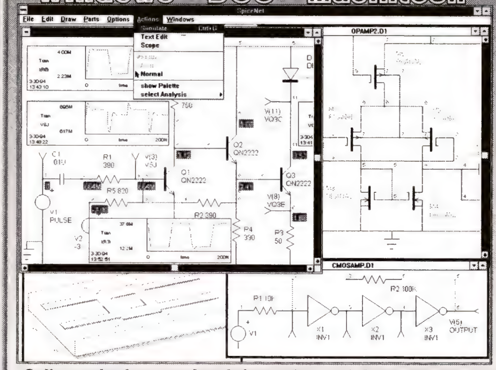

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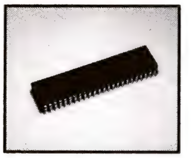

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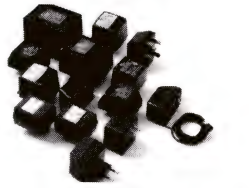

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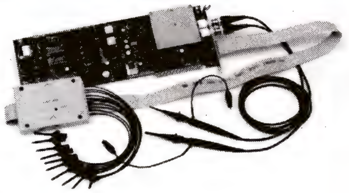

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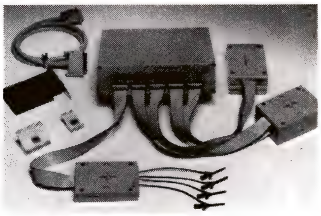

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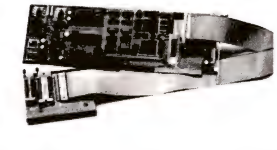

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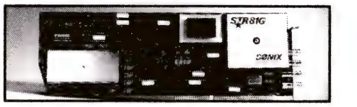

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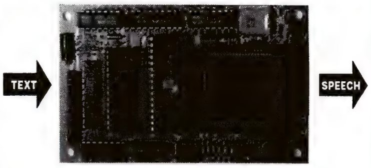

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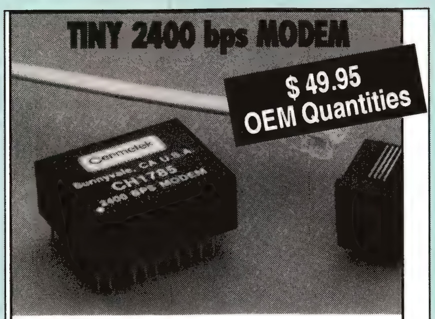

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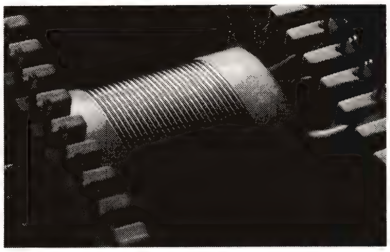

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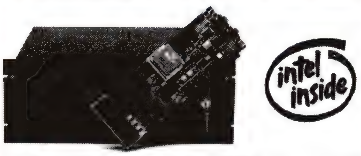

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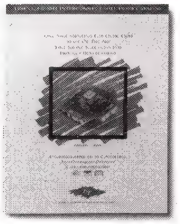

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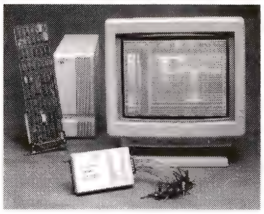

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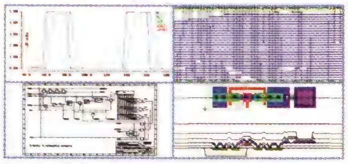

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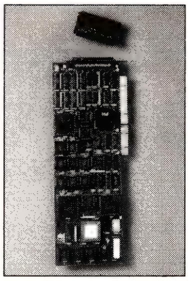

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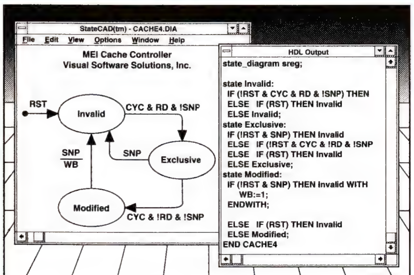

```
state_diagram sreg;

state Invalid:
 IF (!RST & CYC & RD & !SNP) THEN
 ELSE  IF (RST) THEN Invalid
 ELSE Invalid;
state Exclusive:
 IF (!RST & SNP) THEN Invalid
 ELSE  IF (!RST & CYC & !RD & !SNP
 ELSE  IF (RST) THEN Invalid
 ELSE Exclusive;
state Modified:
 IF (!RST & SNP) THEN Invalid WITH
    WB:=1;
 ENDWITH;

 ELSE  IF (RST) THEN Invalid
 ELSE Modified;
END CACHE4
```

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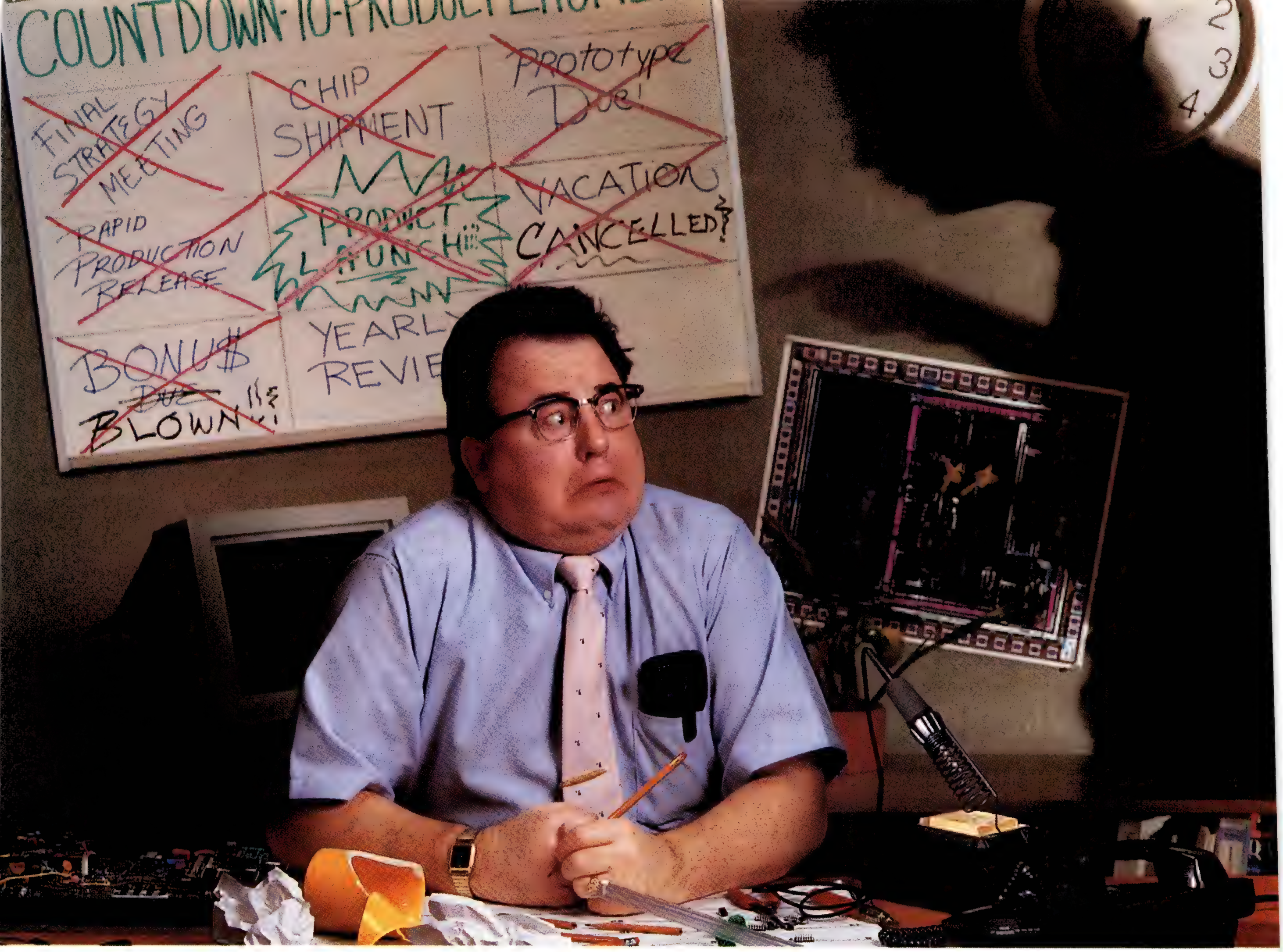

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Z86C06	Masked	18	1K	144	14	12	PDIP, SOIC	Now
Z86E06	OTP	18	1K	144	14	12	PDIP, SOIC	Q3
Z86C08	Masked	18	2K	144	14	12	PDIP, SOIC	Now
Z86E08	OTP	18	2K	144	14	12	PDIP, SOIC	Now
Z86C31	Masked	28	2K	256	24	8	PDIP, Chip Carrier	Now
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Additionally, the standard SPICE2G.6 files are available on several bulletin boards. To download the files, call DOM Engineering Services at (512) 477-0756, the *EDN* Readers' bulletin-board system (BBS) SPICE Special Interest Group (/SPICE) at (617) 558-4241, or the Intusoft on Compuserve.

—Charles H Small

Practical RF-transistor info—all in one place

If you're bewildered by RF-transistor spec sheets, perplexed by the weird circuit-board layouts needed for UHF designs, or confronted with the choice between bipolar and MOSFET types for your RF design, *Radio Frequency Transistors—Principles and Practical Applications* by Norm Dye and Helge Granberg will make a useful addition to your bookshelf.

You can probably find most of the information in this book in various application notes, technical articles, and other reference works. The authors attempt to assemble the information in one place so that the book acts as a single source of information on RF transistors.

The first three chapters cover the parameters and characteristics of RF transistors. First, the authors discuss dc parameters, such as h_{FE} and the various leakage currents and breakdown voltages. Next, you receive guidelines on how to interpret the maximum ratings in a data sheet, with respect to breakdown voltages, maximum power dissipation, and thermal resistance (Θ_{JC}).

Small-signal and power transistors need different testing and specifying approaches. For the power devices, the authors emphasize ruggedness specs and characteristics and discuss the importance of testing and characterizing complex input and output impedances. For small-signal devices, the writers dwell on S-parameters, various gain specs, noise figures, noise resistance, and the 1-dB compression point (a measure of linearity).

A discussion of linear modules illustrates all the first-, second-, and third-order distortion components that can arise with a 3-frequency signal at the input. A half-page table lists all the components. A comprehensive treatment of distortion products explains how to use a parameter called "intercept point" to determine the value of distortion for any signal level.

In Chapter 2, the authors dig deeper into the characteristics of low- and high-power RF transistors. For example, they cover bandwidth considerations, compare bipolar and MOSFET devices, and explain the influence of various modulation methods.

Chapter 3 provides an in-depth comparison between bipolar and MOSFET transistors. Two comprehensive tables provide a wealth of comparative information. The first compares input impedance, biasing, linearity, stability, and ruggedness. The second table relates the nearest equivalent data-sheet parameters for the two transistor types. It lists breakdown voltages, leakage currents, saturation characteristics, dc gain, unity-gain frequency, power gain, and capacitances.

The third chapter also discusses the three basic gain connections and the three amplifier types: common emitter/source, common base/gate, and common collector/drain. The authors provide insight into the applicability of each configuration to particular frequency ranges, circuit applications, and driving and loading environments. They also give extensive information and circuitry for biasing bipolar and MOSFET types for optimum performance, efficiency, and reliability.

Two chapters discuss die temperature vs reliability (with practical advice on how not to maim or kill devices) and types of available packages. The authors provide plenty of instructions on how to mount RF transistors and on laying out circuit boards using microstrip techniques.

A chapter on power-amplifier design covers single-ended, parallel, and push-pull amplifiers, comparing bipolar and MOSFET devices. The discussion treats both lumped- and distributed-component circuits. Large sections on matching networks and stability considerations give ample information on these crucial aspects of RF design.

A chapter on CAD for microwaves emphasizes the need for computer assistance for these complex circuits. The text recommends such programs as EEsof's Touchstone and Optotek's MMICAD. The authors devote much of the CAD discussion to Motorola's free MIMP impedance-matching software, a menu-driven program that generates Smith charts.

Chapter 9 shows you how to design VSWR protection circuits and lowpass filters for an amplifier. A later chapter shows how to design power splitters and combiners for multiple amplifiers. Chapter 10 covers wideband impedance matching, giving techniques for designing matching transformers using coaxial cable, twisted wire, and transmission lines. Caveats about the use of ferrite or powdered-iron cores raise the twin specters of saturation and nonlinearity.

The final chapter provides a comprehensive treatment of small-signal amplifier design, using scattering and noise parameters and Smith charts. Five practical examples lead you step-by-step through the procedures.

I find this book to be quite readable, and it should be indispensable to anyone designing RF transistors.

—Bill Travis

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Bill Travis is a free-lance technical writer based in Worcester, MA.

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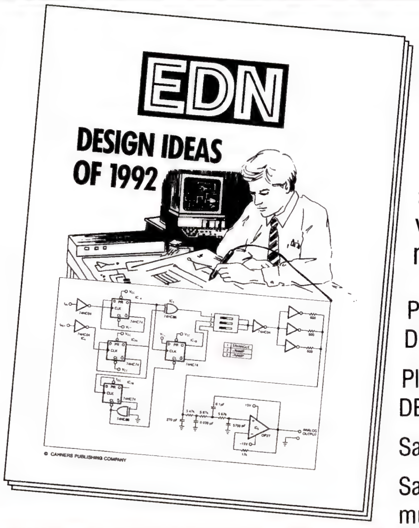

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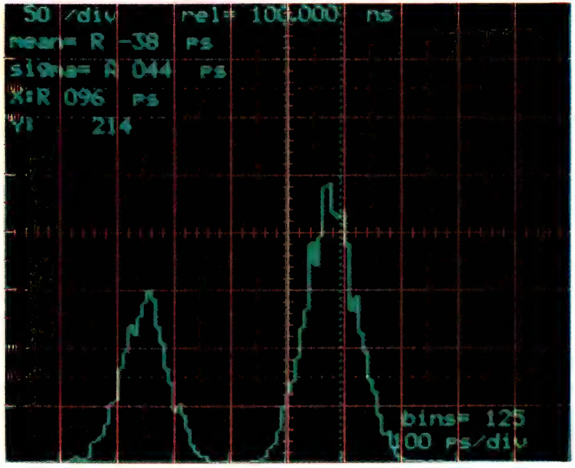

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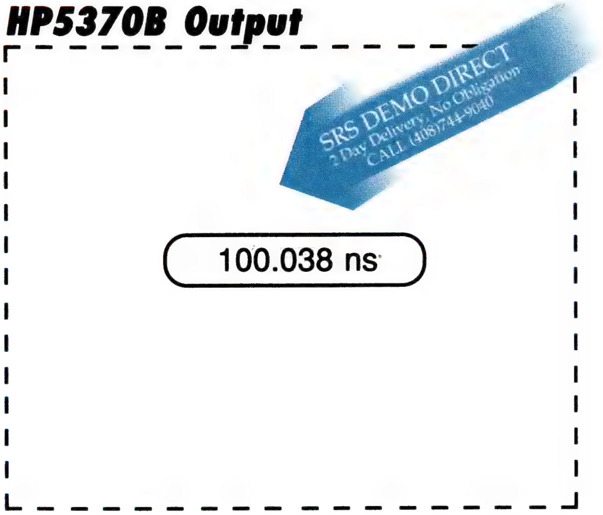

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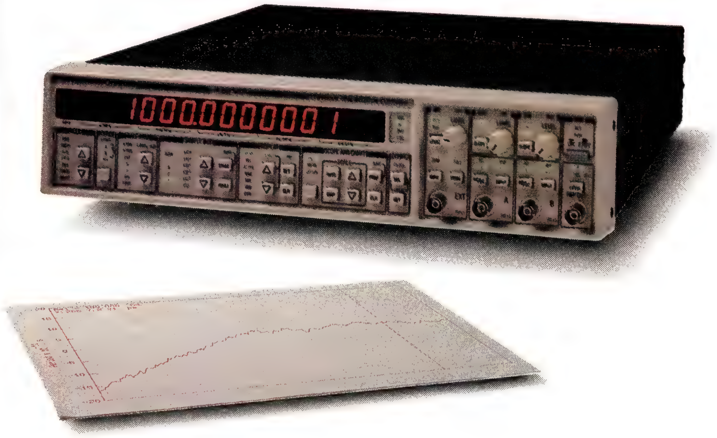

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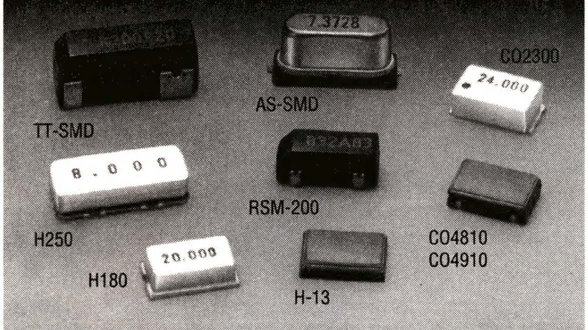

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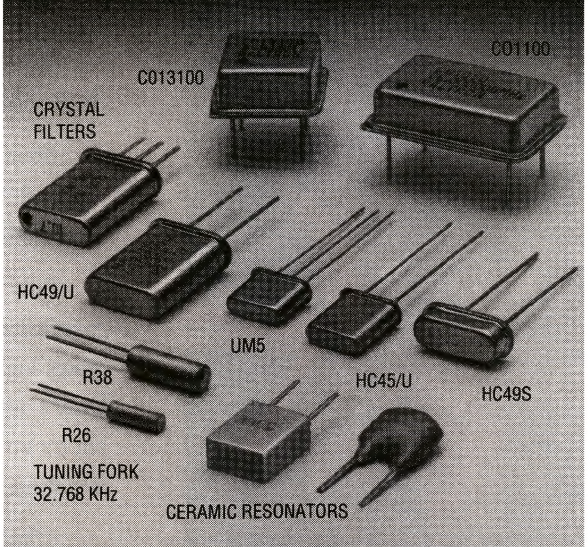

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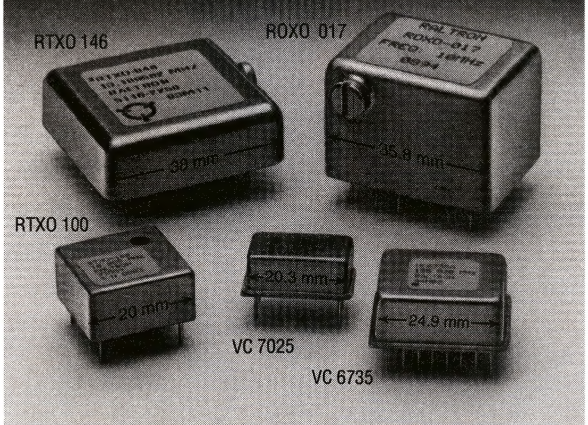

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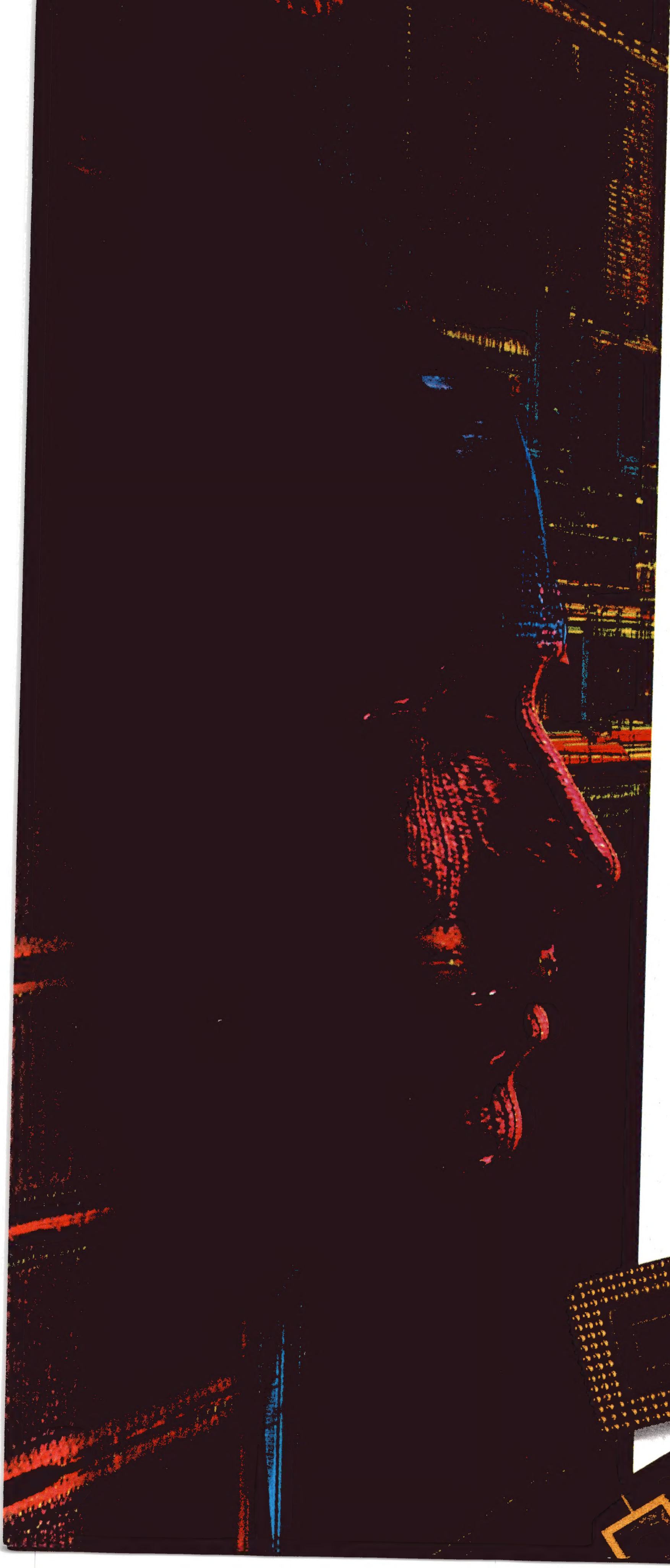

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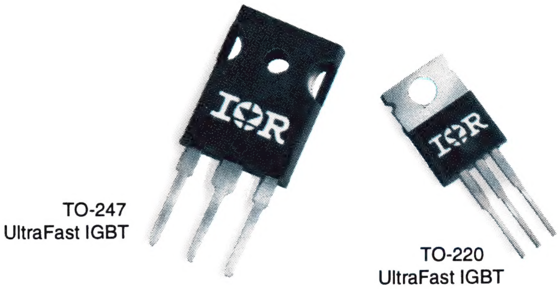

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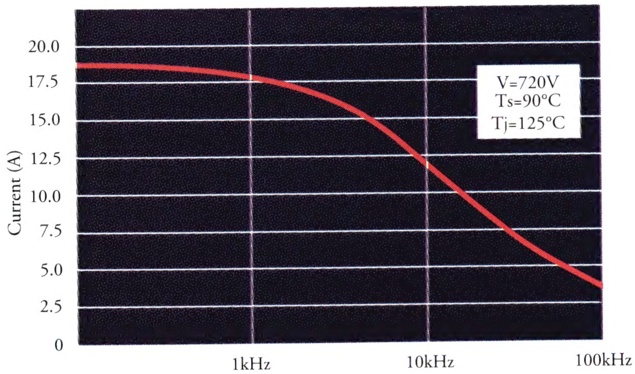

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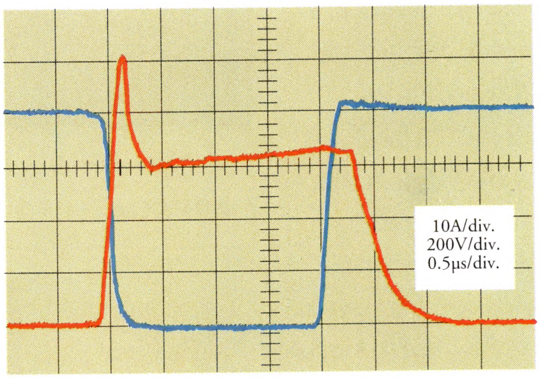

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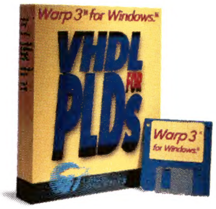

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